Creation/Evolution

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About this issue . . .

We open with an article by leading creationist Dr. Norman Geisler, an article that provides one of the clearest cases for design that has been written in recent years. A philosophical response to Dr. Geisler's argument is provided by Frederick Edwords. Then Dr. William Thwaites uses Geisler's article as a starting point to launch into a general discussion on probabilities, natural selection, self-replication, and biological "design." This takes the reader beyond the point and counterpoint of Geisler and Edwords by providing a background understanding of biological mechanisms.

Because creationists often claim that the first moon landing offered direct observational evidence that modern theories about the great age of the moon (and the solar system) are in error, Dr. Awbrey has produced an effective response. He has investigated the creationists' own sources, plus additional material from the scientific literature on astronomy, and made this data available to show why the creationist conclusion is in error.

Continuing the exploration of biblical literature begun in the spring issue, Frederick Greenspahn offers us further insights into the various creation traditions that appear in Scripture. His article presents additional evidence that the Bible and "scientific creationism" are worlds apart.

Discussions of articles appearing in past issues close out this issue, with special emphasis being placed on Robert Moore's article on Noah's Ark, one of the most popular articles to ever appear in these pages.

All news items have been saved for a big news wrap-up next issue. That will be the last time news items will appear in the pages of *Creation/Evolution*. Starting with Issue XV, all news items will be published in the *Creation/Evolution Newsletter*, published separately by the Committees of Correspondence. *Creation/Evolution* journal will be exclusively devoted to articles and features. Joint subscription to the two publications will be available (see the notice on the back cover of this issue).

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P.O. Box 146, Amherst Branch
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Staff: Editor, Frederick Edwords; Associate Editor, Philip Osmon

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A Scientific Basis for Creation: The Principle of Uniformity

Norman L. Geisler

In crossing a valley, suppose I come upon a round stratified stone and were asked how it came to be such. I might plausibly answer that it was once laid down by water in layers which later solidified by chemical action. One day it broke from a larger section of rock and was subsequently rounded by the natural processes of tumbling and water. Suppose then, upon walking further, I come upon Mount Rushmore where four human faces appear on a granite cliff.[1] Even if I knew nothing about the origin of the faces, would I not come immediately to believe it was an intelligent production and not the result of natural processes of erosion?

Yet why should a natural cause serve for the stone but not for the faces? For this reason, namely, that when we come to inspect the faces on the rock we perceive—what we could not discover in the stone—that they manifest intelligent contrivance, that they convey information. The stone has redundant patterns or strata easily explainable by the observed natural process of sedimentation. The faces, however, have specially formed features, not merely repeated lines. The stone has rounded features like those we observe to result from natural erosion. The faces, on the other hand, have sharply formed features contrary to those made by erosion. In fact, the faces resemble things known to be made by intelligent artisans. These differences being observed, the stone face requires intelligence as its cause. Hence, we would rightly conclude, there must have existed at some time and at some place or other some intelligence that formed them.

Nor would it, I apprehend, weaken the conclusion if we had never seen such a face being chiseled in granite, that we had never known an artisan capable of making one, or that we were wholly incapable of executing such a piece of workmanship ourselves. All this is no more than what is true of some lost art or of some of the more curious productions of modern technology.

Neither, secondly, would it invalidate our conclusion that upon closer

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Dr. Geisler teaches in the Department of Systematic Theology at Dallas Theological Seminary, has written twenty-two books on theological subjects, and testified in support of the Arkansas creationism law in 1981.

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examination of the faces they turn out to be imperfectly formed. It is not necessary that a representation be perfect in order to show it was designed.

Nor, thirdly, would it bring any uncertainty in the argument if we were not able to recognize the identity of the faces. Even if we had never known of any such person portrayed, we would still conclude it took intelligence to produce them.

Nor, fourthly, would any man in his senses think the existence of the faces on the rock were accounted for by being told that they were one out of many possible combinations or forms rocks may take, and that this configuration might be exhibited as well as a different structure.

Nor, fifthly, would it yield our inquiry more satisfaction to be answered that there exists in granite a law or principle of order which had disposed it toward facial forms. We never knew a sculpture made by such a principle of order, nor can we even form an idea of what is meant by such a principle of order distinct from intelligence.

Sixthly, we would be surprised to hear that configurations like this on a mountain side were no proof of intelligent creation but were only to induce the mind to think so.

Seventhly, we would be not less surprised to be informed that the faces resulted simply from the natural processes of wind and water erosion.

Nor, eighthly, would it change our conclusion were we to discover that certain natural objects or powers were utilized in producing the faces. Still the managing of these forces, the pointing and directing them to form the faces, demands intelligence.

Neither, ninethly, would it make the slightest difference in our conclusion were we to discover these natural laws were set up by some intelligent being. For nothing is added to the power of natural laws by positing an original designer for them. Designed or not, the natural powers of wind and rain erosion never produce a human face in granite.[2]

Nor, tenthly, would it change the matter were we to discover that behind the forehead of a stone face was a computer capable of reproducing other faces on nearby cliffs by laser beams. This would only enhance our respect for the intelligence which designed such a computer.

And, furthermore, were we to find that this computer was designed by another computer we would still not give up our belief in an intelligent cause. In fact, we would have an even greater admiration for the intelligence it takes to create computers which can also create.

Further, would we not consider it strange if anyone suggested there was no need for an intelligent cause because there might be an infinite regress of computers designing computers? We know that increasing the number of computers in the series does not diminish the need for intelligence to program the whole series.

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Neither would we allow any limitation on our conclusion (that it takes intelligence to create such information) by the claim that this principle applies only to events of the near past but not the most remote past. For what is remote to us is near to those remote from us.

And would we not consider it arbitrary for anyone to insist that the word "science" applies to our reasoning only if we assume the face had a natural cause, such as erosion, but not if we conclude it had an intelligent source? For who would insist that an archaeologist is scientific only if he posits a non-intelligent natural cause of ancient pottery and tools?

Neither, lastly, would we be driven from our conclusion or from confidence in it by being told we knew nothing at all about how the faces were produced. We know enough to conclude it took intelligence to produce them. The consciousness of knowing little need not beget a distrust of that which we do know. And we do know that natural forces never produce those kinds of effects. We know that the faces on the rock manifest a form such as is produced by intelligence. For "wherever we see marks of contrivance, we are led for its cause to an *intelligent* author. And this transition of the understanding is found upon uniform experience."[3]

Now in like manner, suppose in exploring a cave we come upon a beautifully formed crystal. Would the order of its redundant patterns and the beauty of its symmetry lead us naturally to conclude it was formed by a creator? Not necessarily. Purely natural processes regularly produce such redundant order as is found in crystals.

Suppose, on the other hand, in studying the genetic structure of a living organism, we discover that the DNA of each cell has a highly complicated and unique information code. Further, suppose we find that the information in even a single-celled organism is equal to that of one volume of an Encyclopedia. Suppose, also, we discover that *the information in living cells follows the same pattern as do combinations of letters used by intelligent beings to convey information.*[4] Suppose, further, we find that the information content of non-living proteins is nearly random and that "nothing which even vaguely resembles a code [of life] exists in the physio-chemical world."[5] Noting all this, would we not conclude that it took intelligence to produce a living organism? And would we not arrive at this position with the same degree of confidence with which we concluded that it took intelligence to inform the rock to take the shape of a face?

And were we in addition to discover that the human brain contains more genetic information than the world's largest libraries, would we not reject without further reflection any suggestion that the vast "library" of the brain might have emerged naturally from a more simple one "volume" organism without intelligent intervention?[6]

Neither, I believe, would we be dissuaded from our conclusion of the

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need for intelligent creation of the human mind by the fact that there are many other "books" in the library of living things with similar but less complex information. For experience indicates that similar information in different books never transfers from one to another, either in the printing and shipping process, or as they come in contact on library shelves.

And it is doubtful whether any sensible person would change his conviction on these matters were it known that print is sometimes changed by natural processes (aging, damage). Nor would our view change if we heard that occasionally words leap inexplicably from one book to another. Still we are confident that such changes and transfers of print would take intelligent guidance to result in real information, not confusion. Common sense reveals that information is never transformed from lower to higher forms except by intelligent intervention. For we know that even though all the words of *Hamlet* are in the Oxford Dictionary, nonetheless it takes intelligence to produce *Hamlet* out of a dictionary.

Whence comes this assurance that information is caused by intelligence and that information transformation to higher codes takes intelligent manipulation? Is it not the "uniform experience" of all rational men? For has anyone ever observed an encyclopedia result from a fan blowing on alphabet cereal? Does making random mistakes in copying "Mary had a little lamb . . ." over long periods of time ever result in a Milton's *Paradise Lost*? Do we ever observe either the origin or improvements in complex information except by intelligent intervention?

Further, so firmly is the principle of uniformity established in our belief that we would be greatly surprised to hear that someone has put monkeys at typewriters, expecting them to produce a work of Shakespeare.[7] Or that someone is dropping marbles on a computer keyboard in the expectation of producing a superior program for it.

So certain are we that only minds convey information that when ancient inscriptions in unknown languages are discovered we do not hesitate to conclude some intelligent being inscribed them. And were astronomers to receive a decodeable message from outer space there would be no reason to conclude that it emanated from anything but an intelligent source.[8]

What is the basis of this confidence that it takes intelligence to originate such information? Is it not our uniform experience? And is it not true, to quote David Hume, that "a *uniform experience* amounts to a proof, [so that] there is here a direct and full *proof* from the nature of the fact. . . ."[9]

In short, is not our belief in the need for intelligence to produce the various information codes of living things based on the scientific principle of uniformity—"the present is the key to the past"? And since we did not *observe* the origin of living things, does it not follow that our *speculations* about these past events are entirely dependent on the trustworthiness of the principle

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of uniformity? But in view of the fact that our experience uniformly indicates the need for intelligence to create such information, is not the belief in a non-intelligent natural cause of living things contrary to the principle of uniformity on which scientific understanding of the past depends?

References

1. I am indebted for this illustration to Dr. Charles Thaxton of Richardson, Texas.
2. Even the principle of "natural selection" is never observed producing an entirely new form of life. Natural selection is a principle known to be helpful in the *conservation* of existing organisms, but not in the *production* of totally new ones. Darwinians admit that the famous peppered moth "experiments beautifully demonstrate natural selection—or survival of the fittest—in action. But they do not show evolution in progress. For however the populations may alter in their content of light, intermediate, or dark forms, all the moths remain from beginning to end *biston betularia*." L. Harrison Matthews, "Introduction" to Charles Darwin, *Origin of Species*, London: Dent, 1971, p. XI.
3. See William Paley, *Natural Theology*, ed. by Frederick Ferré, New York: The Bobbs-Merrill Co., 1963 (first published 1802), p. 37.
4. Recently this interesting fact was brought to light by an American scientist who wrote: "The statistical structure of any printed language ranges through letter frequencies, diagrams, trigrams, word frequencies, etc., spelling rules, grammar and so forth and therefore can be represented by a Markov process given the states of the system. . . ." He adds, this same "sequence hypothesis applies directly to the protein and genetic text as well as to written language and therefore the treatment is mathematically identical." See Hubert P. Yockey, "Self Organization Origin of Life Scenarios and Information Theory" in *Journal of Theoretical Biology* (1981), 91.
5. Yockey shows that "the information content of modern proteins reflects a complexity nearly that of a random sequence. . . ." He adds, "The order in the naturally formed amino acid polymers is therefore an impediment and not a means of 'self organization' which leads to informational biomolecules and from thence to a genome." *Ibid.*, p. 26.
6. One scientist wrote.

   > The information content of the human brain expressed in bits is probably comparable to the total number of connections among the neurons—about a hundred trillion, 10^{14}, bits. If written out in English that information would fill some twenty million volumes, as many as in the world's largest libraries.

   Carl Sagan, *Cosmos*. New York: Random House, 1980, p. 278.
7. The famous British astronomer, Sir Fred Hoyle, recently concluded:

   > No matter how large the environment one considers, life cannot have had a random beginning. Troops of monkeys thundering away at random on typewriters could not produce the works of Shakespeare, for the practical reason that the whole observable universe is not large enough to contain the necessary monkey hordes, the necessary typewriters, and certainly the waste paper baskets required for the deposition of wrong attempts. The same is true for living material.

   Sir Fred Hoyle and N. C. Wickramasinghe, *Evolution from Space*, London: Dent, 1981, p. 148.

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8. One famous astronomer wrote: "The receipt of a *single message* from space would show [earth dwellers] that it is possible to live through such technological adolescence [as we are now in]: the transmitting civilization, after all, has survived." See Carl Sagan, *Broca's Brain*, New York: Random House, 1979, p. 275 (emphasis added).
9. See David Hume, *Enquiry Concerning Human Understanding*, New York: The Bobbs-Merrill Co., 1955 (first published 1748), p. 123 (no emphasis added).

An Answer to Dr. Geisler— From the Perspective of Philosophy

Frederick Edwords

The analogical design argument, because of its inadequacy in furthering the cause of theism, seems to be in some disrepute today among leading theologians. It is usually relegated, along with most of the other arguments in the repertoire of 18th century natural theology, to the history of philosophy. However, Dr. Geisler has given us a more contemporary formulation and, therefore, deserves a more contemporary answer.

It is important to keep in mind that an answer to his argument is not tantamount to a case for atheism. The best a good answer can do is show that, among proposed proofs for God, *this* argument won't cut the mustard. That is all that this response is intended to accomplish.

The first way in which Geisler modernizes the traditional analogical design argument is by basing it on the scientific principle of uniformity—that "the present is the key to the past." However, his use of that principle as a basis renders any success he achieves devastating to the claims of most of his fellow creationists. These people don't seem to share Geisler's apparent enthusiasm for uniformitarianism. The story of the worldwide flood and other alleged catastrophic creation events involves processes not observable today. Thus one cannot have both the creation "model" and Geisler's argu-

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Fred Edwords, editor of Creation/Evolution, ***has lectured and debated widely on the creation-evolution question. He is on the board of the National Center for Science Education and is National Administrator of the American Humanist Association.***

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ment from design. Of course, Geisler may actually reject the creation "model" and merely desire to prove a designer. If so, he is not properly a part of the scientific creationist movement and we can cease this line of criticism.

Still, his use of the principle of uniformity is a problem. The principle of uniformity is a naturalistic premise. One uses this principle precisely because one is not admitting miraculous, mysterious, or other processes into the argument, processes that are commonly called up in support of supernatural powers. Yet Geisler uses this principle apparently to demonstrate a supernatural designer. This is contradictory: arguing from naturalism to prove supernaturalism. In logic, a conclusion is never allowed to refute its premise, yet this is precisely what Geisler seeks to accomplish.

Can we save Geisler's argument by dropping the appeals to uniformitarianism? No we can't. The whole argument is dependant on a very weak analogy which breaks down as soon as it is examined. Following the lead of Matson in *The Existence of God* (pp. 123-125), let's clarify the argument by condensing it down to a single syllogism and then look at it more closely. Geisler's modernized version of William Paley's argument can be summarized in the following way:

> Life forms share with artifacts the common possession of a patterned information content.
>
> Artifacts possess this patterned information content because they are products of intelligent design.
>
> Therefore, life forms possess this patterned information content because they too are products of intelligent design.

That is really all Geisler has said. As a result, we are left with some questions. For example, is the intelligent design that is claimed to be evident in life forms the product of a supernatural being, or only of a human being? Since Geisler is following Paley, I would assume the intent is to prove that life forms were created by a supernatural being who, in addition, created the entire universe. But Geisler's argument doesn't actually say that. It only declares that the design evident in artifacts is also present in life forms. Who did the designing? Humans? "Ancient astronauts"? Some assembly line somewhere? There is really nothing in the argument to compel us to look outside nature for the designing intelligence. And there is nothing to compel us to imagine that the designer(s) is even still alive. The analogy will work in quite a number of ways. As a result, even if correct it would prove very little.

These issues aside, there is the greater problem that the analogy isn't very complete. Even if we agreed that Geisler had made a case for the supernatural intelligent design of life, we would still have to carry the analogy further. How was this life designed? We can find out by asking how Mt. Rushmore was designed. Our answer will be that the sculptor went through a learning

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process wherein he made many mistakes, then he made smaller and different works of sculpture, then he made various experimental models of Mt. Rushmore before choosing the one he liked, and finally he made, over a long period of time, Mt. Rushmore. Thus, Geisler's case for a designer becomes more of a case for a tinkerer. Now if we add the entire history of sculpture that led up to Mt. Rushmore, we have a case for a whole long history of tinkerers who passed on their acquired skills and techniques. Thus Geisler's analogy, if valid, best supports a case for polytheism and multiple creations!

Seeing the full effects of the argument, let us now apply the same sort of analogy to another case. The result should be an argument that is equally as true or as false as the previous one.

> Life forms share with artifacts the common usual characteristic of being colored.
>
> Artifacts have color because often they are painted or dyed.
>
> Therefore, life forms have color because often they too are painted or dyed.

To some, this argument might suggest a divine painter, artistic "ancient astronauts," or humans who go around dying animals. All the living things with color might be used to support such conclusions.

Of course this painter analogy is clearly silly. But since Geisler's argument follows the same pattern, it shares the same judgement. His is too weak an analogy to work or be useful and must therefore be rejected as unhelpful to the cause.

But let's not stop here. Let's look at different applications that Geisler makes of his analogy to see if he even applies it consistently.

If we start with the example of crystals in a cave, we actually see that he rejects his analogy outright. He agrees that crystals show apparent design, but he accepts that such design occurs through purely natural causes because he agrees with scientists who say that natural causes are known to "regularly produce such redundant order." Why, then, does he have trouble believing that *life* can form or change by natural causes? There are no lack of scientists who say that it can and who refer to known natural causes. So if he can depart from his analogy when it comes to crystals, why not when it comes to life? Does one idea bother him more than the other?

The rationale that Geisler provides for his inconsistent position is that life possesses a code that crystals are without and hence crystals display only "redundant order." Are these facts significant? Crystals, particularly snow crystals, possess an intricate symmetry that eroded stones are without, but did that stop Geisler from, in effect, putting crystals on a par with stones? Not at all. Yet it would seem that if it takes intelligence to make a design, even a design with "redundant order," by analogy it must take intelligence

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to make a snow crystal. The redundancy in the pattern of the crystal is no more an argument against its being designed than is the redundancy in the pattern of mass-produced models of Mt. Rushmore sold in South Dakota souvenir shops. One can't selectively use the analogy for sculpture and life but not snow crystals just because sculpture and life have different characteristics from snow crystals. They have characteristics different from each other as well!

Of course, Geisler goes on to argue that the human brain is incredibly complex, possessing information sufficient to fill the world's largest libraries. Is this argument grounds for giving the brain special consideration over snow crystals? Not if you consider that snow crystals, though individually less complex than the human brain, often appear in great abundance, with no two designs being alike. These designs, if translated into sculpture, would exceed the capacity of the world's largest art galleries. So why doesn't Geisler reject, "without further reflection," any suggestion that this vast art gallery of the skies might have emerged naturally from simple rain drops frozen around dust particles. His mind should reel at the improbability of such massive amounts of original artwork arising spontaneously by purely natural means! Yet he actually has no trouble accepting the natural origin of crystals.

Now let's go to the analogy of the watchmaker and see if his use of that is consistent.

In the watchmaker analogy, William Paley compared finding a watch to finding a well-organized life form. Now, I will grant that if I have experienced seeing watches made by watchmakers, and then I later see a watch on the ground, my common sense will tell me that this artifact was made by a watchmaker. Even if I see an unfamiliar manufactured object, I will most likely immediately recognize it as an artifact. But if the unfamiliar object I see doesn't look like anything I have ever seen produced by human hands, I have no analogy to draw upon. For example, I've never seen life created or a creator of life. Thus I can't claim that uniform experience leads me to the idea of intelligent design in life forms.

Geisler says, however, that coming to his conclusion is as scientific as the conclusions arrived at by archaeologists. This is clearly false. Archaeologists have uniform experience to draw upon; Geisler does not. Chemists are having some trouble showing how life could come from non-life for precisely the same reason. There is only a small amount of uniform experience to draw upon. Uniform experience comes more abundantly, however, in the matter of the evolutionary changing of one life form into another. There the scientist draws upon observed small changes in life forms today and an observed fossil record that shows systematic variation. He observes that the present is analogous to the past and so he draws the commonsense conclusion that

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evolution is the cause behind present life forms being the way they are. Geisler seems unwilling to apply *this* analogy.

In the Mt. Rushmore example, Geisler doesn't think that any person in his senses would attempt to account for the faces in the rock by arguing that these are just among the forms rocks may naturally take, that there might be a mechanism operating in the rocks causing them to form what only *appear* to be sculptured faces. By analogy, he clearly implies that if we see apparent design in life forms, we should not attempt to account for it with similar arguments (though it is seemingly alright to account for apparent design in crystals this way).

This analogy might fit if we really had no knowledge or idea of processes or laws that could bring about life forms so organized that some people would think they were designed. But we *do* have such knowledge. In the case of Mt. Rushmore, then, if we had actual evidence to support the existence of some natural face-forming mechanism operating in the rocks, we would not be foolish to accept this evidence. Looking at the body of knowledge in science today, however, we learn of no mechanism like Geisler described operating within rocks, but we do learn of a mechanism affecting life forms. This mechanism is natural selection. Analogies become less important once one has evidence of the existence of the mechanism at issue.

Let's pursue this further. Paley argued that intelligently designed objects show "marks of contrivance" whereas objects that are not designed don't. Geisler follows this line by arguing that the DNA code is such a "mark of contrivance" and hence life forms were designed. What he fails to consider is that a so-called "mark of contrivance" can be caused by a mechanism other than intelligent design. As the evidence now stands, there are two known sources of these marks, human intelligence and natural selection. The "marks of contrivance" on Mt. Rushmore and in a library can be explained by human intelligence. The "marks of contrivance" of the DNA code can be explained by the process of natural selection. Therefore, there is no essential reason why a person must be limited to seeking an intelligent designer, particularly a supernatural one, for the complexity found in life.

It is curious that Geisler makes no mention of this mechanism except in his second footnote. And when he does mention it there, he shows that he misunderstands it by his improper limiting of its scope. No doubt, if scientists were as unaware of the power of natural selection as Geisler seems to be, they too, being stuck with purely random natural events as the only alternative, might be tempted to imagine an intelligence behind the DNA code.

Apparently Geisler believes that natural selection only weeds out misfits and maintains the purity, as it were, of the original life form. But for him to take this position, he has to hold that life forms are never known to change, a position that runs directly contrary to the evidence. Beneficial

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mutations are frequently observed in animals, there are new strains of virus and bacterium that arise, and animals are sometimes observed to adapt in small ways to their environment, occasionally in ways that make it difficult or impossible for them to interbreed with the original life forms from which they evolved.

For Geisler to suggest that these changes don't represent the production of "an entirely new form of life" is for him to get caught up in the largely semantic issue of species definition. Categories like species, family, order, and so forth are pretty much arbitrary divisions developed (and constantly revised) by scientists for the sake of convenience. Different specialists, in fact, divide life forms differently. So the supposed difficulty in observing the formation of "an entirely new form of life" has no significance. Given the small changes we see, sufficient time, and the absence of any force to prevent the accumulation of these small changes, evolution on larger and larger scales becomes inevitable. This is due mostly to the combination of mutation and natural selection.

A good part of Geisler's analogical argument depends on the supposed easiness of separating artifacts from natural objects. But it isn't always that easy. A person could conceivably smooth a stone in such a way that it was indistinguishable from one smoothed by a stream. How could anyone judge which was which? If a stone face in the side of a mountain were carved crudely enough, it might be impossible to distinguish it from natural features. By the same token, some natural features bear an uncanny resemblance to human-made objects, often to the point that they have been mistaken for such. One of the most recent examples is the creationist mistaking of random erosional features along the Paluxy River for human footprints. In the Smithsonian natural history museum there is an exhibit on "false fossils," and one item is a fossil "horseshoe print" that, in reality, is a random feature of the rock. Because of these facts, Geisler's criterion is unsuitable and unreliable. The appearance of "marks of contrivance" can be deceptive and their absence proves nothing.

Sitting back and looking at the broad outlines of Geisler's argument, it becomes clear that he is using analogy to show that life forms resemble artifacts in the possession of the features of "intelligent design." Then he is using the principle of uniformity to show that intelligent design is always the result of an intelligent being. Nowhere does he specify the nature of the intelligent being responsible for life, making his whole case appear, on the face of it, to be an argument supporting the *human* creation of all life. But, were we to raise that possibility seriously, Geisler would no doubt repeat his point about "the intelligence it takes to create computers which can also create." He would ask us what intelligence created the human intelligence that supposedly created life. This would take us where his paper by itself does not, into the

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realm of the supernatural. But when we got there, and he told us that the buck stops with the supernatural creator, would we not be justified in repeating his own question about the intelligence necessary to create intelligence that can create? After all, he established it in the beginning that complex information content implies design and that design requires a designer. Well, the supernatural creator would certainly show evidence of complex information content, hence design. So, by Geisler's own rules, the supernatural creator would require its own creator, *ad infinitum*.

Geisler's point about the infinite regress not being acceptable does not save him from the consequences of having his conclusion defeat his premises. It merely shows that, while he finds an infinite regress unacceptable, he perhaps has no difficulty with self-contradiction. And the infinite regress doesn't even have to be there. This is a problem of Geisler's own making. He adopted as a basic principle that design requires a designer. This has the infinite regress already built in! The solution seems to require that Geisler get off of the "intelligent designer" bandwagon and opt for a natural, non-intelligent source of human creativity. But that would lead him straight to naturalistic evolution, a predictable conclusion for an argument beginning with naturalistic premises.

Reference

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An Answer to Dr. Geisler— From the Perspective of Biology

William M. Thwaites

To most of us in science, the two-century old views of William Paley seem quaint, but we forget just how many people have been left behind on this subject. In fact, so many have been left behind on both the vitalism versus mechanism and the creation versus evolution controversies that we even find non-creationists reaching conclusions similar to those of the creationists regarding the origin of life. Geisler cited two such people who are well-known in creationist-anticreationist circles: the Hoyle and Wickramasinghe (1982) team for one and Hubert Yockey (1977, 1981) for the other.

Yockey seems to have achieved his fame by being frequently quoted by creationists, yet, so far as I know, he is not a religiously motivated creationist himself. I agree with others who say that his probability calculations are "shot through with errors" (Doolittle, 1983). However, his appeal for scientific skepticism is welcome. As for Hoyle and Wickramasinghe, neither accepts the creation "model," though the latter witnessed in defense of the Arkansas creationism law. Regardless of the general lack of sympathy these people seem to have for the complete creationist position, they have supplied some of the major arguments creationists use. In this paper I'd like to explain where the creationists and their non-religious sympathizers seem to have erred concerning the question of design.

Randomized DNA is still DNA.

First let's take up the familiar "hurricane in a junk yard," "electric fan and alphabet cereal," and "monkeys at typewriters" examples, while at the same time paying attention to the relevant biochemistry. All these colorful images miss at least one crucially important point. Life very likely got its start with a very special chemical called RNA. RNA (ribonucleic acid) has all sorts of properties that we are just beginning to discover. A very recent finding showed that not only can RNA carry coded genetic information, but it also can carry out specific chemical reactions that were previously thought to be

Dr. Thwaites is a professor of biology at San Diego State University where he conducts a two-model creation-evolution course. He has debated creationists on various occasions.

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the exclusive domain of proteins (Lewin, 1982). Prior to this finding, origin-of-life theoreticians were faced with a chicken and egg type of problem. Present-day life uses nucleic acids, both RNA and its close relative DNA, to direct the synthesis of proteins. Some of these proteins are needed for both DNA and protein synthesis. The old puzzle was where the first proteins came from to help DNA and RNA direct protein synthesis. While a lot of work remains to be done in this new area, we now know that the question was naive. The claim that life couldn't have started with nucleic acids since they would have had no help from proteins seemed reasonable only until someone discovered that RNA can function as if it were a protein. That solved the problem.

Such impossibility arguments are awfully difficult to make in science because they depend so heavily on initial assumptions. It takes a rather arrogant person to claim that he has constructed an air-tight impossibility argument for something. Such a person says that he knows all the boundary conditions for a particular situation. I, for one, tend to go with the ideas of people who are willing to admit that we don't know everything. I know that origin-of-life scenarios get more and more detailed and plausible as each passing year brings more knowledge.

Another thing about nucleic acids that the "bull in the china shop" people tend to overlook is the almost infinite number of possible configurations a former china shop can take on compared to the far more limited number of sequences a damaged piece of DNA can acquire. The genetic code that DNA carries can change, but it is still DNA, whereas the destroyed china shop could take on almost any shape imaginable. The damaged DNA still has the same chemistry, the same beautiful symmetry, the same spiral staircase configuration, the same width from one side of the "staircase" to the other, the same base pairing across each rung of the staircase, the same phosphate—sugar—phosphate—sugar backbone in each strand, and the same lack of an oxygen molecule at the number two position of each and every sugar. A miracle? Well, no, not unless all chemistry is miraculous.

Now compare this with the "hurricane in the junk yard" or even Geisler's "alphabet cereal." Would the cereal land in neat rows with all the letters right side up? Is there an automatic process that would save any cereal word groups that made any sense at all? Would those word groups that made a little sense make copies of themselves? Would some of the copies have trivial errors, and would the automatic selection process save any copies that happened to say something new? Would the copies that had the most useful information replicate themselves faster than those that had less useful information? Since mutated (randomized) DNA is still DNA, and since DNA is capable of self-replication, DNA and its precursors yield a "yes" answer to the forgoing questions, while the cereal example gives a "no."

Another major problem with Geisler's alphabet cereal analogy is his

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insistence that an evolutionary goal be set up in advance. He says we would never get an *encyclopedia*. That's a very specific goal. Geisler implies that he wouldn't be impressed if we got a poem, a pretty design, or a phone book. Only an encyclopedia will do. Geisler's fatal error is that evolution does not work toward an ultimate goal, but is strictly opportunistic. Anything that helps ensure the continued replication of a self-replicating species is saved.

I'd like to illustrate how adding more chemically appropriate assumptions to the alphabet cereal example makes the idea of getting a book seem far more plausible. I must confess that I used Scrabble® letters rather than alphabet cereal. This was just a matter of convenience for me. The change shouldn't alter the probabilities very much. I put the randomized letters in a nice neat row, the way they would be in RNA or DNA. Finally I looked for any recognizable words. This is essentially what natural selection does with nucleic acids. Eigen and his colleagues (1981) have done a good job of explaining observations that have shown replicating nucleic acids responding directly to natural selection, so the supposition that this could happen is not just wishful thinking.

I found the word "copy" in the first seven Scrabble® letters. Before I had fifty letters on the table the sentence "Get it." appeared. Overall I had found nine letters out of fifty that made up words. That's about ten percent.

Yockey and many creationists would probably calculate the probability of this happening in the following manner. There are nine uniquely specified letters with twenty-six letters to choose from at each of the nine positions; therefore the chance of finding "Copy. Get it." would be 1/26th to the ninth power, or about two chances out of ten trillion tries. Indeed, if I went looking for "Copy. Get it." or even another sentence with the same "information content" the next time I played this game, I might spend quite a while looking. On the other hand searching for *any* words is a much easier game. Evolution seems to work in a very similar manner.

Generally, we tend to think that the most intelligent animal has to be warm-blooded and hairy with a segmented backbone because that's the way things are. But how would we go about showing that this is the *only* way? If some new change is helpful, that's all that should matter. Why insist on solution "A" if solution "W/KJ37AGR" and an almost infinite number of similar solutions also work?

Alphabet cereal, junk yards, and other creationist analogies are very different entities from self-replicating systems. Geisler does mention the idea of Mt. Rushmore's directing the synthesis of new Mt. Rushmores (heaven help us!), but he doesn't begin to explore the ultimate ramifications of such a system were it to have the ability to mutate and respond to selection. Were this possible, Mt. Rushmore would constitute a new form of life. By the time all the natural cliffs in the world had been obliterated by this self-replicating

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monstrosity we might expect to see more than former presidents. Natural selection and random change would have left their marks on each new generation of Rushmores. If we were to find such a life form, it would certainly be a puzzle to biologists. For, unlike organic life, it would be far more difficult to postulate a natural origin for it.

So, if after centuries of fruitless investigation we were unable to formulate a natural origin for this cliff-wrecker organism, we might be forced to postulate intelligent creation, perhaps by some misguided alien. But no legitimate scientist would postulate a supernatural origin for the cliff-wrecker since the notion would suggest no further research. A supernatural hypothesis in science is the ultimate form of an impossibility statement. It would say, in effect, "I can't find a natural cause for this observation, therefore no natural cause exists." Greater arrogance is difficult to imagine.

Natural selection has been shown to be creative.

All through Geisler's article he reasons that if something in life is interesting, complex, and/or apparently clever, one must conclude that it has been designed by some outside intelligence. Well, this isn't always true. I can't think of a better way to illustrate this than to cite a series of experiments conducted by Barry Hall at the University of Connecticut (1982). His work has centered on the evolution of a new gene complex in the common bacterium *E. coli*. He has taken a strain that has completely lost a gene and the associated genetic mechanism that regulates its activity. Starting with this defective strain he has utilized an environment that confers an extreme selective advantage to any bacterium able to reinvent, so to speak, the missing gene and its regulatory mechanism. Finally he has studied at the molecular level the "solutions" found by the bacterium. The newly evolved genes naturally have many features in common with each other, but they also show a considerable amount of creativity. Some solutions are elegant and some appear to be rather awkwardly complex. They all work, however. If complexity were a measure of design, we would have to say they were all designed. Yet we know the genes *evolved* in the laboratory. Barry Hall did not design the new genes no matter how much the creationists may wish to think that he did.

I can think of two creationist comebacks to Hall's work. One would say that *E. coli* must have been designed by a very clever creator to be able to evolve so well. Such a response really isn't too helpful to the creationist cause. The other reply would simply claim that the evolution of a single gene and some regulatory apparatus to go with it is trivial evolution "within" created kinds, and thus is of no real significance to the creation-evolution

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debate. They would say that the *E. coli* with the newly evolved genes are still *E. coli* and not a horse or a tiger. But if the evolution of new genes is trivial and expected by creationists, then all creationist arguments about entropy and probability are also trivial, since these supposedly prevent the evolution of new genes.

Hall's articles are very heavy reading for non-biologists and even for many biologists. Perhaps that is the reason they have not been widely referenced in the creation-evolution context before this. Anyone who is going to claim impossibilities in the area of evolution at the molecular level should make a special point of reading and understanding just what Hall has observed with *E. coli*.

Determinination of origins is not a look-and-know operation.

Geisler starts out his article with an elaborate explanation of how we know about the desecration of Mt. Rushmore. We are supposed to conclude that it was created, but in fact his criteria don't always work as well as he implies. Before his death Louis Leaky found what he said were human artifacts in the Western United States. There was little disagreement that the location of these "artifacts" made them older than any other aboriginal artifacts on this continent by many fold. But there still is disagreement as to whether they are in fact artifacts. In real life it isn't quite so easy to tell if a rock with a funny shape actually is an artifact.

Certainly amost every scenic spot in the world has some type of imagined sculptured object. I remember guided tours of a limestone cave near Madison, Wisconsin. In the cave were stone slabs of bacon, frying pans, faces, creatures, and what not. None of them showed the mark of the sculptor's chisel. In fact the cave had been carefully kept in its natural state since its discovery a few years before my well-supervised visits. The point is that it is sometimes difficult to tell, just by looking, whether something is in its natural state. Geisler's look-and-know tests are just not very powerful by themselves.

If we really want to know if something could have come to its present state through natural processes, we must try to find out if there are natural processes that are equal to the task. We would feel very confident in our "natural processes" conclusion if we found that these same processes are going on today. Of course we find that evolution fills the bill as an ongoing process, one capable of explaining the origins of both contemporary and fossil organisms. With this information in hand, we no longer have to rely on look-and-know approaches to uncovering "origins."

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Evidence of Design by Nature

It would be instructive at this point to briefly mention some of the major design arguments for evolution. There is a tremendous body of evidence that points to an evolutionary heritage, rather than some form of intelligent creation heritage, for living things. Let's start with vestigial organs.

Although creationists usually dismiss vestigial organs by saying that they have some function we don't yet understand, there are some excellent examples of vestigial organs that are not vulnerable to such criticism. These are the vestigial organs which only occur sporadically in a few individuals of a population. One example that comes to mind is that of supernumerary nipples in humans. When these occur along the mammary ridge they recall our primitive mammalian ancestors that almost certainly had nipples distributed along the mammary ridge. Since most members of our species seem to get along quite well without these extra mammary glands, we can safely conclude that they are vestigial organs that serve no useful function.

One well-known creationist friend of mine, after hearing the supernumerary nipple argument for evolutionary design, had this to say: "Extra nipples in the armpit region should convince evolutionists that we are descended from bats since their mammary glands are similarly located. And extra mammary glands located in the abdominal area would require evolutionists to believe that we have risen from whales." I doubt if I could get permission to assign this quote to a specific creationist since it should be obvious to all that the reasonable evolutionary conclusion is that bats, whales, and people are all descendants of a common ancester that did in fact have rows of nipples along its ventral (front) surface. The creationist's response was nothing more than the old "straw man" debating technique.

The situation is identical for sperm whales. (See "True Vestigial Structures in Whales and Dolphins," Conrad, 1982.) Most members of the species get along very well without hind limbs, yet a few have stubby hind limbs complete with the appropriate hind limb bones. I am waiting for some creationist to tell me that such limbs are examples of degeneration in accord with the second law of thermodynamics. I'd love to ask from what sort of animal the sperm whale degenerated. Why did the original "created kind" have hind limbs? To climb onto the Ark perhaps? To their collective credit, however, no creationists have yet suggested anything like this.

Certainly no elementary discussion of design would be complete without the mention of pathogens and parasites. Such organisms are completely understandable in evolutionary terms, but if they are the products of God's creation, it takes some contorted logic to save His beneficence. Invariably this involves blaming the victim. Misery exists because humans have sinned. Not only does evolution make more sense, but it relieves any supernatural forces,

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whatever they might be, from blame. And experience in the medical sciences has shown us that a non-supernatural approach to the study of disease has been quite productive in the alleviation of human suffering. In my opinion, every school child should be treated to what Darwin had to say on the subject. In a letter to Asa Grey he said the following:

> With respect to the theological view of the question . . . This is always painful to me. I am bewildered. I had no intention to write atheistically. But I own that I cannot see as plainly as others do, and as I should wish to do, evidence of design and beneficence on all sides of us. There seems to me too much misery in the world. I cannot persuade myself that a beneficent and omnipotent God would have designedly created the Ichneumonidae with the express intention of their feeding within the living bodies of caterpillars, or that a cat would play with mice. Not believing this, I see no necessity in the belief that the eye was expressly designed (1860).

It would be easy to go on with a veritable encyclopedia of design by evolution observations. Practically everything in biology can easily be interpreted in this way. All we need to do is ask how things would look if an omnipotent and beneficent deity had designed them and how they would look if they were the products of evolution.

For one person, the odd structure of the mammalian kidney was enough to convince her of the validity of the evolutionary viewpoint. (The kidney gets rid of an enormous volume of water in the manner of the fishes, but then must turn right around and reabsorb most of it since mammals aren't fresh water fishes.) For another person it might be the realization that vertebrates are cursed with an inside-out retina in the eye. (The nerves and blood vessels that serve the light sensitive cells pass in front of them partially obscuring the field of view. Octopuses and other cephalopods have the retinas of their eyes put together correctly with the nerves and blood vessels tucked behind the photosensitive cells.) Did God at the time of the "Fall" turn the vertebrate retina inside-out, or is the vertebrate eye a separate evolutionary accomplishment from the cephalopod eye?

There is a particularly humorous example from the history of science that calls into serious question the divine design hypothesis of creationists while, at the same time, serving to underscore the evolutionary success and taxonomic diversity of the order Coleoptera. Perhaps the story has been embellished through the years. I haven't traced the quote to the original, but it is reported that Biologist J. B. S. Haldane was asked by a reporter, "What characteristic of the deity do you chiefly discern in the design of creation?" Haldane's now famous response is reported to have been, "An inordinate fondness for beetles."

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Whether true or not, the quote captures the essence of modern divine design considerations. If we take the time to consider biology in any depth at all, we are left with a picture of a bumbling and frivolous god, one who tinkers and constantly tries minor adjustments, and who frequently doesn't get things right. The god that emerges from this type of analysis is far more concerned with the continued ability to make copies of genetic information than with the welfare of any particular species such as *Homo sapiens*.

On the other hand, if design considerations really show design by mutation, natural selection, and chance, one really isn't saying anything about the attributes of a deity, whether positively or negatively. From the standpoint of religion, it would seem far better to argue that life got here through the natural process of evolution than to argue that the Judaeo-Christian god is a bumbling and cruel oaf. From the standpoint of science, however, nothing can be said about the supernatural. That's why we call it natural science.

Conclusion

It was through references to the notion of design that Darwin convinced most of his contemporaries of the validity of evolution. Nature makes an overwhelming case for design by natural mechanisms as opposed to design by external intelligence. Gould provides many simple intuitive examples of this in *The Panda's Thumb* (1980).

In the face of this, it is ironic that many creationists claim that design arguments are their most successful tool for keeping the faithful faithful. Perhaps they have found such success only because few people since Darwin's time have presented to the public the much more persuasive case for design by natural mechanisms. Hopefully this exchange with Dr. Geisler will show many on the evolution side how to improve their presentation of the case for evolution.

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Space Dust, The Moon's Surface, and the Age of the Cosmos

Frank T. Awbrey

A central claim of scientific creationism is "a relatively recent creation of the earth and the universe." However, creationist scientists are very difficult to pin down about just how old the earth is. Specific answers tend to get them in trouble because skeptics can then check the claim against facts. Inevitably, this leads to the creationist claim being exposed as wrong or even foolish.

For example, anyone who cares to do so can add 4004 BC to 1983 and find that Archbishop Ussher's biblical age for the universe is 5987 years. Some quick addition of the begats in Genesis shows that Noah's flood came 1646 years after the creation. That adds up to 2348 BC, or 4331 years ago. If Henry Morris (1980) is right that "all true facts of nature" support Biblical creationism, then the student of history would expect to find signs that some of the Egyptian pyramids had been inundated. Rather than confront fact after fact that refutes their deeply held beliefs, scientific creationists simply attack the theory of evolution and make vague claims that their own "model" is supported by abundant scientific evidence.

Often, the creationist claim of "a relatively recent creation" is so imprecise that it could mean any time ranging from 5987 years to tens of millions of years ago. This claim is usually "supported" by attacking the validity of radiometric and other dating techniques (Morris, 1974, pp. 131-169; Slusher, 1981). The total lack of substance in these attacks has been shown in devastating critiques by Dalrymple and Brush.

The creationist response is very simple—when pushed, evade the question by stating that the evidence is not relevant because a young earth is optional to the creation model anyway (Hahn, 1982). Otherwise, ignore the critics and continue to claim that the "true facts of nature" show the earth to be quite young. Stick with complex subjects such as radiometric dating, magnetic field decay, sun shrinkage, tidal slowing of the earth's spin rate, etc. Dazzle the uninitiated with some calculations. Creationists get away with this chicanery because their intended audience is unlikely to check those calculations and the assumptions behind them.

Dr. Awbrey is a professor of biology at San Diego State University where he has helped conduct a two-model creation-evolution course. He has debated creationists on several occasions.

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Cosmic Dust

Occasionally, however, creationists pick an example that seems safely complex, but is actually easy to understand even without elaborate calculations. One such example is the cosmic dust argument. Creationists have calculated that the amount of cosmic dust on the moon could have accumulated in less than ten thousand years. In fact, they claim, had dust been accumulating for billions of years, it would be hundreds or even thousands of feet thick and the lunar landing space craft would have sunk out of sight. To creationists, the survival of moon landers proves that the moon, and the rest of the universe, must be young. A closer look at this claim and subsequent statements about it provides some insight into how creationist "science" is done.

Cosmic dust calculations abound in creationist literature. In *Scientific Creationism* (pp. 151-152), the authors present numbers to show that the earth and moon should have a thick layer of dust if they were 4.5 billion years old. Kofahl and Segraves (p. 146), Whitcomb and DeYoung (pp. 94-95), Slusher (1980, p. 41), and Hahn (pp. 553-555) all repeat the same argument that the moon should have accumulated thick layers of dust in 4.5 billion years and that the 65 millimeters (2½ inches) actually there could have accumulated in less than ten thousand years.

Now, any such calculations must be based on data. In this case, the creationist's data source is a 1960 *Scientific American* article by H. Pettersson. Working before we had actual space dust measurements from satellites, Pettersson measured atmospheric dust filtered from the air atop Mauna Loa in Hawaii and then attempted to estimate how much of that dust came from space. He knew that only a tiny fraction of the dust he collected came from space. To estimate how much meteoritic dust there was, Pettersson used the fact that nickel is much rarer in terrestrial dust than in meteorites. He made reasonable assumptions that meteorites averaged about 2.5% nickel and that all the nickel in his dust samples came from meteors. Then he simply weighed the nickel in his samples and divided by .025 to get the total weight of space dust in the volume of air that passed through his filters. With an uncertain assumption about how fast dust settled out of the atmosphere, Pettersson figured that 14 million tons of space dust settled on earth each year. Because this figure was much higher than estimates based on other data, Pettersson said five million tons per year was plausible. Like any reputable scientist, he presented his assumptions and warned that unknowns made his estimate very speculative.

Astrophysicists were aware of Pettersson's estimate and there was some speculation that space craft sent to the moon might sink into a thick layer of fine dust. None were terribly surprised when that did not happen. Nevertheless, creationists took Pettersson's 14 million ton estimate as fact, plugged it

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into their equations and "proved" that the cosmos was less than 10,000 years old. Kofahl and Segraves (p. 146) even stated that astronomers were dismayed because the moon did not have the expected thick dust layer and that "there is a noticeable silence on this matter in current discussions of moon data." A similar comment appears in *Scientific Creationism* (p. 152). Now we have another standard creationist charge; that evolutionists and their allies suppress evidence unfavorable to evolution. The facts tell a different story.

Astrophysicists are vitally interested in cosmic dust calculations because micrometeorites are potentially hazardous to satellites and other space craft. Therefore, Pettersson's method for determining cosmic dust abundance in the earth's vicinity is only one of many different indirect methods being used. Others include zodiacal light refraction, photographic recording of light streaks from meteors entering the atmosphere, and measurement of concentrations in atmospheric dust, deep-sea bottom sediments, and Antarctic ice cores of elements, such as iridium and osmium, that are rare on earth but common in some meteors.

One of the earliest priorities of the space program was to make direct measurements of particulates in space in order to calibrate the indirect methods. By 1968, a year before the first man stepped onto the moon, a wide variety of data was available, and, in 1972, J. S. Dohnanyi reviewed an extensive literature on space dust influx. Uncertainties still existed, but those making indirect estimates then had to make many fewer assumptions than Pettersson did.

Dohnanyi discusses several of these estimates. The highest of these, iridium and osmium concentrations in deep-sea sediments, would yield about ½ meter (19 inches) of dust on earth in 4.5 billion years. A recent estimate by Ganapathy, based on iridium in ice cores, is that 400 thousand tons of space dust fall on the earth each year. That is 1/35th of Pettersson's highest estimate, or 1.6 meters (5.2 feet) of dust in 5 billion years instead of the 55.5 meters (182 feet) calculated by a creationist in *Scientific Creationism* (p. 152).

In contrast with the uncertainties associated with earth-based methods of estimating cosmic dust concentration, satellites in space can measure it directly. Using data from dust penetration of satellites, Dohnanyi gave the following direct measurements of cosmic dust influx rates: To the earth 4×10^{-9} grams/per square centimeter (22.6 thousand tons) per year, and to the moon 2×10^{-9} grams per square centimeter (11.3 thousand tons) per year. Assuming a constant influx rate (even though it certainly wasn't) the earth would collect a layer of dust only 60 millimeters (2.4 inches) thick in 4.5 billion years and the moon half that. This does not take into account the contribution to earth of larger meteoroids, such as the Tunguska object (Ganapathy), that break up on entering the atmosphere. Given the extreme

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irregularity of such objects, both in size and arrival, the actual dust influx certainly lies somewhere between 23 thousand and 400 thousand tons per year. None of these figures is in any way inconsistent with the concentrations of cobalt, nickel, osmium or iridium in the earth's crust (nor, as he pointed out, was Pettersson's estimate), in spite of the numerical shenanigans and semantic trickery creationists use (e.g., Morris, 1974, p. 152-3) to make their claim that the facts can be explained only if the earth is no more than a few thousand years old. Once again, a close look at the facts shows that creationists are wrong.

That the claim of a conspiracy of silence among supporters of evolution is a patent falsehood should be apparent to all by now. A glance at the references cited by Dohnanyi and Ganapathy shows clearly that, far from being suppressed, these data and the calculations made from them were available and widely discussed in the open scientific literature for at least six years before the creationists began publishing their claim that moon dust calculations provide scientific evidence supporting "a relatively recent creation." The only suppression of real moon dust data seems to be in creationist literature. As far as the creationist's followers know, Pettersson's 1960 article still represents the latest word on the subject. One would think that after data had been available for at least 15 years, any creationists doing research on a subject so important to them would surely have run across the information, especially now that computer searches of the literature are cheap and accessible to all. Amazingly, in the June 1983 ICR Impact article, Bliss proffers cosmic dust (and several other discredited ideas) as support for creationism, proving mainly the author's ignorance of the "true facts of nature."

The Surface of the Moon

The antiquity of the solar system should be obvious to anyone who has thought about the pictures and moon rocks brought back by the Apollo program. Before anyone had actually been to the moon's surface, scientists had predicted how it should look. The moon has no atmosphere and no free water, therefore it has no weather. Its surface is cratered, implying volcanic activity and meteorite impacts. Without weather, there could be no erosion, so any mountains, lava formations, and impact debris should remain forever as sharp and jagged as the day they were formed. Based on this reasoning, the famous paintings produced in the 1940's and '50's by Chesley Bonestell, which were based on the best scientific guesses of the moon's appearance at the time, all showed extremely jagged mountains, rocks and craters.

Figure 1 is an artist's rendition of how the scene in the lunar highlands photographed by the astronauts of Apollo 17 was originally expected to look.

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Figure 1. Artist's rendition of how Apollo 13 site in lunar highlands should have appeared according to best information available before actual pictures from the surface were available. With no atmosphere, and hence no weather to erode them, all rocks, craters, and lava formations would remain unaltered indefinitely.

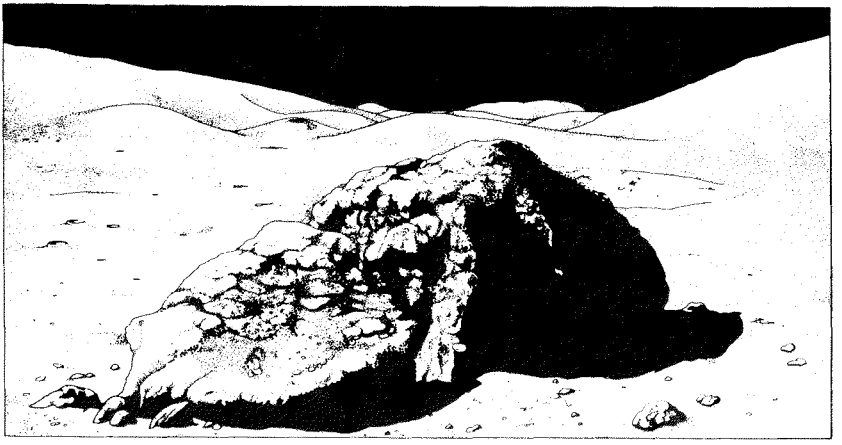

Figure 2. Artist's drawing from Apollo 13 photograph of scene in figure 1. Note that all exposed surfaces have been worn and rounded by erosion. Exposed surfaces of the boulder in the foreground have a substantial cover of dirt.

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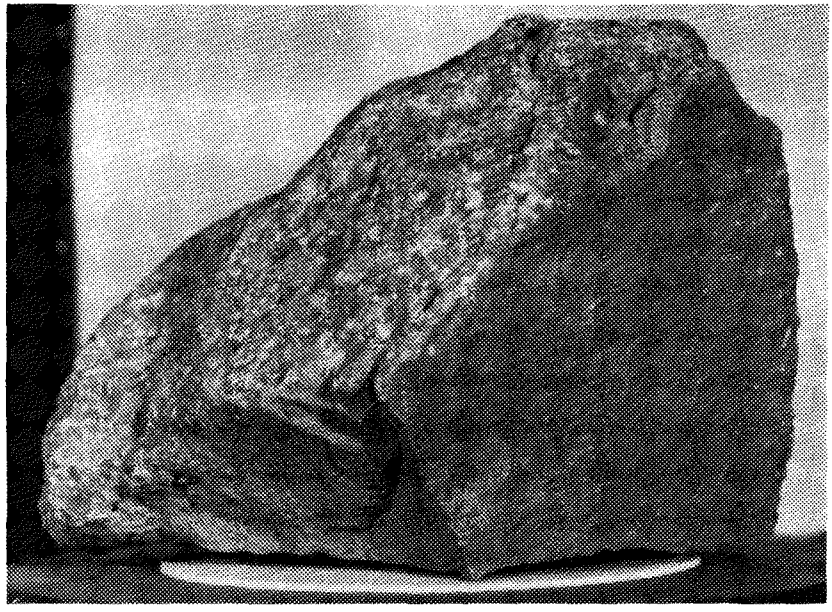

Figure 3. NASA moon rock 14310. This rock was found partially buried on the moon's surface where it had lain since being broken off a larger rock. The surfaces that were buried are angular and unmarked. The exposed surface, in contrast, is covered with many small pits that were made by small space dust particles striking at speeds up to 10 kilometers per second (11,000 miles per hour). This slow process, which has rounded the exposed surface, accounts for nearly all lunar erosion. The rock is about 19 centimeters (7½ inches) wide.

Figure 2 is how it actually looked. The boulder is well rounded, as are the mountains and the crater edges. Without weather, what could account for such profound erosion?

Examination of moon rocks (fig. 3) provides the answer. The rock surfaces that were buried are sharp and angular, as expected, but all exposed surfaces are rounded off and severely pitted. The rock obviously has been struck by many small, high velocity objects. We know now that these objects are micrometeoroids, interplanetary dust grains averaging between 10^{-8} and 10^{-14} grams each. Ninety-five percent of these particles hit the surface at speeds over 10 kilometers per second (about 11000 miles per hour), producing impact craters ranging from 1 micrometer to 1 millimeter (1/25,000 to 1/25 inch) in diameter. McDonnell and Ashworth calculate that circular tar-

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gets between 1 millimeter and 10 meters in diameter would be eroded away at one to three billionths of a meter per year, assuming they weren't hit by micrometeoroids large enough to shatter them. At that rate, a surface that had all debris removed would be worn down 13.5 meters (44.3 feet) in 4.5 billion years. (They are not worn down that much because the debris is not removed. Subsequent impacts merely grind the surface material finer and finer.) Therefore, a one-inch deep footprint on the moon would still be detectable after eight million years!

Even if this calculation of the erosion rate were off by one or two orders of magnitude, an enormous time span was necessary for the moon's surface to become so profoundly eroded. If the moon were only ten thousand years old, only 30 micrometers (1.2 millionths of an inch) would have eroded away. The astronauts might have been able to detect the resulting dust coat with a clean white glove, but it wouldn't have been easy.

In many places on the moon, sediment-like layers are visible. These were not deposited by water. Instead, they are layers of ejecta from the large meteroids that made craters a few meters to many kilometers in diameter. The slow bombardment from space then slowly broke the top rocks of the resulting layer of debris into finer and finer pieces. After a few tens to hundreds of millions of years, another large meteoroid hit and deposited another layer of newly broken rock atop this one and the erosion process repeated. This process is illustrated in an article by Eglinton and others and accounts nicely for the layered appearance of some lunar formations.

Regarding the moon, then, the "true facts of nature" are that the surface is highly eroded, that this erosion was caused by micrometeoroid bombardment, and that micrometeoroids (i.e., space dust) rain down onto the moon very slowly. We now need to examine how well these facts are explained by the mechanisms that creationist scientists offer in explaining earth and moon geology.

One possible mechanism would be decay in accordance with the second law of thermodynamics. A moment's reflection should cause any rational person to realize how inadequate this is. Somehow the moon's mountains, with no water or weather, would have to erode away many times faster than mountains on the earth, where the measurable effects of water and weather are by far the most important agents of erosion. Degeneration of this sort also would not produce sediment-like layers. Mountains crumbling rapidly would leave jumbled masses of debris rather than neat layers.

Creationists are likely to argue that establishment scientists' arguments are based upon uniformitarianism, the assumption that past processes were the same as the natural processes operating today. The creationist alternative is catastrophism. On earth, that means Noah's flood. In space, Morris (1972, pp. 66-77) isn't quite sure what was involved but he implies that the battered

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appearance of the moon and many other bodies in the solar system may be the result of "continuing cosmic warfare" between Michael and his angels and the minions of Satan.

In evaluating this idea, consider that no one has ever reported seeing the moon enveloped in the huge dust cloud that would have to accompany such violence. That restricts the catastrophe to the short period creationists allow between creation and the beginning of written history, perhaps even to the year of Noah's flood (Whitcomb and DeYoung, p. 97). The mind boggles at trying to imagine what kind of monumental cosmic sandblaster could have reduced the moon's mountains to rounded hills in only a few years while leaving successive layers intact. One has to wonder why so much energy directed at the moon in such a short time didn't melt the surface instead of grinding it to powder. Another problem is that the varying states of erosion of small craters on the moon implies a prolonged, rather than episodic, bombardment. By invoking the miraculous, creationists avoid having to worry about such problems.

In short, creationist catastrophism is not well supported by the facts. It is nothing more than a set of miracles offered up in place of a simple, natural explanation that accords very well with the moon's features and with actual measurements of space dust.

Of course, as a last resort, creationists can always fall back on their old crutch, the omphalos argument (Price, 1980), and claim that the moon was created as it is, dust, impact craters, eroded surfaces and all. Such miracles may satisfy their need to find some kind of support for a cherished belief, but they fall outside the province of science and require rejection of a natural explanation that fits the "true facts of nature" beautifully. So, in spite of creationist's wish otherwise, there is no real support for scientific creationism on the moon or anywhere else.

Acknowledgements

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Biblical Views of Creation

Frederick E. Greenspahn

Although the Bible has been read and studied as Holy Scripture for over twenty centures, two developments within the last few generations have radically affected the way in which we understand this most important book. The more spectacular of these is the impact of archeological research, which is uniquely able to provide us with new sources of information, whether in the form of material remains or through the uncovering and eventual decipherment of additional texts from the ancient world. The second is the rise of modern biblical scholarship, which brings to bear all available tools in an effort to understand the Bible in much the same way that other academic disciplines deal with their subject matter. To be sure, neither of these methods is entirely without precedent. The Bible itself describes how a seventh century Judean ruler was forced to react to the discovery of a "new" text which most scholars today consider to have been some form of Deuteronomy, while the authors of late biblical books had to reconcile contradictory claims in earlier sources.[1] Still, modern biblical studies are usually regarded as beginning some time within the last century or so as the pace of both research and discovery increased to the point where we simply had access to vastly more information than was available to even the most brilliant of earlier generations. As a result, modern scholarship has been able to provide substantial insights into this ancient and revered text.

Relying on our accumulated knowledge of history, languages, and literary techniques, this discipline strives, within the limits of human ability, to understand the Bible and the society from which it emerged on their own terms just as we might any other document or culture. And while, as in any academic discipline, many questions remain open, one can trace a rather clear consensus as to the nature of the Bible, a consensus shared by most scholars whether Protestant, Catholic, or Jewish. It is that consensus which I will attempt to present here insofar as it pertains to the issue of creation. To do so clearly, I will focus on three major points which can be summarized as follows:

Dr. Greenspahn holds a Ph.D. in Biblical Studies from Brandeis University, is an ordained Rabbi, and is Assistant Professor of Judaic Studies at the University of Denver. He has served on the board of the Association for Jewish Studies and is past president of the Rocky Mountain and Great Plains Region of the American Academy of Religion/Society of Biblical Literature.

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1) The Bible (Old Testament) contains several points of view which, despite certain fundamental commonalities, are not always in complete harmony with each other.

2) The biblical accounts of creation are most often a response to other ancient teachings with which the authors have chosen to take issue.

3) The fundamental purpose of the creation narratives is to interpret the meaning of the universe rather than to make a scientific statement as to its origin or history.

1

One way to recognize the diversity of viewpoints found in the Bible is simply to glance at its table of contents. There are books by Amos and Jeremiah, Malachi and Ezekiel. Whatever overall harmony may exist among these figures, no one would expect them to agree on every detail. Scholars recognize that the same kind of compilation process which led to the inclusion of all these writings in our Bible and the exclusion of others was also responsible for the present shape of many individual books.

The most famous, but by no means the only example of this can be found in the first pages of Genesis itself. Chapter one describes the creation of man on the sixth day, after vegetation had been made on the third and animals earlier on the sixth; according to chapter two, however, man preceded these other creations. Chapter one states that woman was created at the same time as man, whereas in chapter two she follows both man and the animals. There is also a rather different tone in each of the two passages. In the first, God creates by fiat; as the psalmist put it, "He spoke, and it came to pass" (Ps. 33:9). In Genesis two, on the other hand, rather than being called into existence, things are formed out of other things. A final distinction is stylistic: in the first chapter God is consistently called "God" (*elohim*), whereas in the second He is spoken of as "LORD God" (*yhwh elohim*). On the basis of this kind of evidence, scholars infer that two originally separate traditions about the creation of the world have been placed side by side at the beginning of Genesis. Of course, there are many common themes running through both passages—human uniqueness and preeminence being just one obvious example. But the stories seem to have separate origins and purposes. The first is concerned to explain the origin of the entire universe—oceans and stars, animal life and vegetation—whereas the second focuses almost exclusively on mankind.

Although most people are familiar with the passages to which I have

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referred and may even be aware of the arguments used to demonstrate their separate origins, not as many people know that Genesis is not the only place in the Bible where creation is described. The book of Proverbs, for example, deals with this theme when it states:

> The LORD by wisdom founded the earth;
> He established the sky with understanding.
> By His knowledge, the deeps broke forth
> and the clouds dripped down the dew. (Prov. 3:19-20)

What this means is made clear in a later passage where wisdom, personified as a woman, describes her role in creation:

> The LORD created me at the beginning of His work,
> the first of His deeds of old.
> Ages ago I was set up, from the beginning, before the earth.
> When there were no depths, I was brought forth,
> when there were no springs abounding with water.
> When the mountains had not yet been sunk in place,
> before the hills, I was brought forth.
> Before He had made the earth and fields or the world's first dust,
> When He established the sky, I was there,
> when He drew a circle on the face of the deep.
> When He made the clouds firm up above,
> when He strengthened the fountains of the deep,
> When He set a limit for the sea
> so that the waters would not transgress His command,
> When He laid out the foundations of the earth –
> then I was beside Him, a master workman.
> And I was His delight every day, rejoicing before Him all the time,
> rejoicing in His world and delighting in mankind. (Prov. 8:22-31)

In other words, Proverbs is describing how something called "wisdom" existed before anything else had been made and actually helped God in the process of creation, even though such an entity is not mentioned anywhere in Genesis. This is an important philosophical assertion with obvious neo-Platonic analogs. Interestingly, later Jewish tradition came to understand wisdom as being Torah while Christianity regarded it as Christ.[2]

The book of Job speaks of God's creating the universe when it describes how

> He hung the earth upon nothing and put water into the clouds . . .
> He drew a circle on the waters, making a boundary between light and darkness . . .
> By His power He calmed the sea, and by His understanding smote Rahab.
> (Job 26:7-12)

According to Isaiah 51:9, Rahab was a dragon (the Hebrew word is *tannin*). Like the "wisdom" mentioned in Proverbs, Rahab is absent from the Genesis account.

Psalm 74 also speaks of creation when it states

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You did divide the sea with Your might;
You smashed the dragon's heads on the waters.
You did crush Leviathan's heads,
Giving him as food for the desert creatures.
You did split open springs and brooks;
You did dry up ever-flowing streams.
Yours is the day, Yours also is the night;
You established the lights and the sun.
You set all the earth's boundaries;
Summer and winter – You made them. (Ps. 74:13-17)

Here, in addition to destroying the dragons (*tannin*), God defeats something called Leviathan which, according to Isaiah 27:1 where it also appears alongside *tannin*, is a snake-like creature. Leviathan is now known from texts excavated from the ancient city of Ugarit, located along the Mediterranean coast somewhat north of Israel. Written in the thirteenth pre-Christian century, these tablets describe Leviathan (there called "Lotan") as a seven-headed, rather convoluted snake.[3] Like Rahab, Leviathan is not mentioned in Genesis.

By examining all such passages throughout the Old Testament, one can reconstruct a story of creation quite different from the more familiar Genesis accounts. Although it obviously never achieved the status of the "canonical" versions, this Israelite myth must have been well enough known for ancient poets to be certain that their audience would understand the allusions. In broad outline, it would have gone something like this:[4]

> At the dawn of history the waters of the sea, acting with the help of Leviathan, Rahab, and the dragon, rose up against God. The Lord's anger was kindled against these rebels whom He rebuked with the thunder of His voice. The rebels trembled and quaked at the sound of the Lord's rebuke; they were smitten by His mighty arm. The Lord calmed the waters and dried up the sea, setting a boundary which it cannot pass so that He might reign forever and ever.

The fate of the various rebels is not entirely certain. Some passages imply that they were pierced or crushed; others, that they were merely forced to acknowledge God's supremacy. In any event, the thrust of this account is clear enough.

2

Once this tale has been reconstructed, it is easily recognizable as a type well-known from several cultures, most especially those of ancient Mesopatamia, the region to which the Israelites traced their own origins (cf. Gen. 11:27ff). These stories describe how the leading god defeated the god of the sea who represents the forces of chaos. Only after his victory could he create the world, using the corpse of his foes or some other divine being. At the end of this process, man is made in order to do the gods' bidding.

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Such accounts are known from several myths; the most famous, called "Enuma Elish" on the basis of its first words, comes from Babylonia.[5] The main points of this myth are common to most or all of its various versions. These are:

1) the belief that creation was the result of a divine battle resulting in the defeat of the chaotic waters or the god who represents them;

2) the fact that the creation of the universe is incidental to the story's main focus;

3) the sense that mankind was created to be a servant of the gods.

All of these, except the last which is not reflected in the available references, find their analogs in our reconstructed Israelite myth in which Israel's God was believed to have defeated the forces of the rebellious waters. More important still is the fact that this same myth is reflected in the much better-known account with which Genesis begins. To be sure, the relationship is not quite so obvious as with the more mythic version reconstructed from poetic allusions; but careful examination reveals the relationship to be every bit as important.

After He had created light on the first day, Genesis 1 tells us that

> God said, "Let there be an expanse in the middle of the waters so that it will separate the waters into two parts. (Gen. 1:6)

In other words, the waters themselves already existed. This can also be seen from the very beginning of the story. Improvements in our understanding of Hebrew grammar, based in part on increased knowledge of other Semitic languages, clearly shows that the first few verses of Genesis actually constitute a single sentence which should be translated:

> When God began to create the heavens and the earth – the earth being chaos and confusion with darkness on the face of the deep and God's wind sweeping over the water – God said, "Let there be light," and there was light. (Gen. 1:1-3)

Again, water is primordial; it need not be created because it already existed when God began the process of creation. A similar idea is reflected in the most ancient of Greek philosophy and, as we have already seen, in Mesopotamian mythology.[6] The result of God's creative activity on the second day was, therefore, to divide this water mass into two parts — water above the sky and water beneath.

On the third day

> God said, "Let the waters which are under the sky be gathered together in one place so that the dry land can be seen." (Gen. 1:9)

Notice that the land was not so much created as made visible by putting all the water to one side, so to speak. This is strikingly different from the other

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Near Eastern stories, including the reconstructed Israelite myth, in that there is no threat from the water nor any battle against it. God's control is absolute: He speaks and it obeys. His sovereignty is demonstrated again on the fifth day when

> God created the great sea monsters. (Gen. 1:21)

The Hebrew term for "sea monsters" is, as you might imagine, *tannin*. We have already observed that this term is a relic from ancient Near Eastern mythology which believed in the existence of primordial monsters. But these monsters do not fight against God on behalf of the forces of chaos; they are rather creatures made by God, part of the very order which permeates this account. Some people may be bothered by the thought that the Bible refers to creatures of this sort; after all, most of us are inclined to doubt the existence of dragons, whether in the ocean or on land. But the point is terribly important for an understanding of Genesis: what other ancient traditions, including some in Israel, considered a threat or enemy of God, Genesis regards as just another divinely made creature.

Once we realize the story's background, then its scientific accuracy becomes quite irrelevant. The message is not so much scientific or historical as theological—that God exercises absolute supremacy and control over a world which is not the accidental by-product of a cosmic struggle between forces of order and chaos, but rather the result of careful planning and organization.[7]

With mankind, too, there is a theological message. To be sure, the Bible regards humanity as subservient to God (we would be surprised if it were otherwise), but not as slaves to a lazy deity in the way Mesopotamian traditions did. Instead, man (and woman as well) is the culmination of the creative process. In Genesis 1 this is implicit in the assertion that Man—both male and female—was created in God's image; in Genesis 2 the same idea emerges from the statement that of all created beings mankind alone is the product not just of soil but of the divine breath as well. And so man is placed as the superintendant over God's new world, an echo perhaps of the pagan point of view which saw man as serving the gods, but with infinitely more dignity than they suggest. According to Genesis, we are God's surrogate, not His slave.

3

How to regard stories like those of Genesis is not, for most of us, simply a matter of personal predilection. We would like also to know how they were regarded by those who decided to include them in the Bible as well as by Jewish and Christian authorities over the centuries since.[8] For this last question

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one cannot in all honesty give a simple and straightforward reply. The Bible's role in Judaism and Christianity has been complex and multi-faceted. Still, both religions have historically agreed that Scripture incorporates many levels of meaning so that it can be interpreted in various ways. In general, Judaism and Christianity are inclined to see the Bible as a source of *religious* truth, rather than as a book filled with scientific facts. That does not mean that past authorities would have been comfortable with the thought that the Bible might lie or slant the truth; but, for the most part, they would not have been upset with the notion that some parts of the Bible are parable rather than history or that the biblical authors might have used metaphor rather than literal statements of fact. Augustine, for example, developed a doctrine according to which God revealed His teachings in accordance with the parameters of human understanding; rather than overwhelming us with the full depth of His knowledge, He accomodated Himself to our limited abilities in much the same way that He had lowered Himself by taking on human form for our benefit.[9] Jewish tradition expresses a similar concept in its assertion that the "Torah speaks in human language."[10] The Bible, then, is conceived as God speaking in a way we (or our ancestors) are capable of understanding, rather than in accordance with His own abilities.

In this regard, we would do well to remember that our own use of the word "truth" is not without its ambiguities. After all, there is the truth of a mathematical proposition like "2 + 2 = 4," the truth of a fable such as Aesop's tortoise and hare (which we accept as true even though we know it never actually took place), and the truth of poetry or other art forms.

Some people view the Bible as embodying the kind of truth found in fables; they expect each biblical narrative to have a moral of some sort. But a fable is a story that is obviously fictional and told solely in order to teach a particular lesson. It is rather doubtful that the authors of Genesis thought of their stories as patently fictitious in the way that Aesop obviously did. Most scholars are therefore more inclined to view the early Genesis narratives as "mythopoeic." Used in this sense, "myth" is not intended to assert that the story is either true or false, but rather that it pertains to a totally different dimension of reality from that which we ordinarily encounter; similarly, "poetic" suggests that the purpose is not merely to assert a scientific fact, but rather to make a very different and perhaps more important kind of statement.

Let us reexamine the Bible's story of creation in this light and seek to understand the point of view on which it is based. For the various myths which regard the universe as resulting from some sort of battle, existence is characterized by competing forces of chaos and order. Our world is an accidental by-product of that struggle, and man plays a limited and wholly subordinate role. For the first chapter of Genesis, everything is reversed. The

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cosmos was created intentionally and in a conspicuously orderly fashion. The sequence is logical. Nothing is created until its needs have been provided for: fish come after oceans, trees after the earth. Nor is this accidental. That things turned out as they were planned is emphasized by God's observation that "it was good," which is repeated after almost every act of creation. This is the world that He meant to be. Moreover, it is not a world in which conflict is the rule. Whereas the ancient Mesopotamian myths see a world in which order and chaos are continually at odds, Genesis sees order as transcending and dominating chaos. For the author of Genesis, there is one power which transcends all others. Mankind is the earthly representative of that power, created in its own image and charged with supervising its world as a kind of mediator between creatures and Creator.

None of this is explicitly stated, but then the book of Genesis is not a philosophical treatise or a scientific monograph. Indeed, there is a striking lack of abstract theology throughout the Old Testament. Consider its first verse: "When God began to create . . ." We are not told who this God is or what; His characteristics are not listed nor His nature probed. He is simply a given, whose nature must be inferred from the acts which are described. The Bible does not often assert its truths in the form of propositions such as we associate with a geometry text; instead, its message is communicated in the manner used by a poem or a painting. The question is not, therefore, whether the Bible is true or false, but rather what kind of truth it seeks to convey.

Conclusion

Having examined evidence from throughout the Bible as well as other ancient Near Eastern cultures and the relevant scholarly disciplines, we are now in a position to reiterate the main theses with which we began and to seek to understand their importance. It perhaps bears repeating that these conclusions are neither radical nor irreligious. They are, essentially, the consensus of modern biblical scholars who come from throughout the Jewish and Christian theological spectrum. Moreover, most of them do not see these conclusions as particularly threatening to their religious faith. Quite the contrary—they tend to believe that true faith must be willing to face facts honestly and that the Bible's religious values can be found only if one is willing to explore it with an open and curious mind rather than with preconceptions as to what we would like it to say.

The Bible, as we have seen, contains a diversity of viewpoints on this as on other matters; its descriptions of creation must be understood in light of the other differing points of view which were prevalent in its own time. Moreover, the Bible is not a science text but a religious one, a fact we overlook

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with surprising frequency, even those of us who regard ourselves as religious. And religion deals not so much with the facts of existence as with their meaning. This is precisely what we find in Genesis—a statement not about the way things came to be, at least not in the manner we associate with modern physics or biology, but rather an assessment of their importance and purpose. Such truths are no less true than those of science, unless one believes Einstein's work is more valid than Mozart's or Newton more important than Rembrandt. They are simply of a different order. Rather than denigrating the Bible, such a view elevates it from the realm of the physical to that of the spiritual, from dealing with ephemeral trivia to communicating concepts about subjects to which we ascribe eternal worth.

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1. For example, Exodus 12:8-9 commands that the Passover sacrifice be roasted (*tsli eysh*) and not boiled in water (*bashel . . . bamayim*), whereas Deuteronomy 16:7 commands that it be boiled (*b-sh-l*). The Chronicler, among the latest of the biblical authors, states that it should be "boiled in fire" (*b-sh-l . . . ba-eysh*, 2 Chron. 35:13). The discovery of the book commonly regarded as Deuteronomy is related in 2 Kings 22-23.
2. The Jewish view is stated explicitly in Genesis Rabba 1:1 (see A. Cohen, *Everyman's Talmud* [New York: E. P. Dutton, 1983], pp. 30-31); it is implicit already in Ben Sirach 24. For the Christian view see the Gospel of John 1:1-3.
3. Translations of these texts can be found in James B. Pritchard, *Ancient Near Eastern Texts Relating to the Old Testament* (3d edition; Princeton: Princeton University Press, 1969), pp. 138-9.
4. The evidence for this assertion and a detailed description of this tradition are presented by Umberto Cassuto, "The Israelite Epic," in *Biblical and Oriental Studies* (Jerusalem: Magnes Press, 1973) vol. 2, pp. 69-109.
5. The Enuma Elish is translated in Pritchard, *op. cit.*, pp. 60-72; other Mesopotamian creation traditions can be found in Alexander Heidel, *The Babylonian Genesis* (Chicago: University of Chicago, 1951), pp. 61-81.
6. See G. S. Kirk and J. E. Raven, *The Presocratic Philosophers* (Cambridge: University Press, 1960), pp. 15-19 and 87-93.
7. See Nahum M. Sarna, *Understanding Genesis* (New York: Schocken Books, 1966), pp. 1-23.
8. For a survey of Christian and Jewish attitudes towards the Bible see Frederick E. Greenspahn, *Scripture in the Jewish and Christian Traditions: Authority, Interpretation, Relevance* (Nashville: Abingdon Press, 1982).
9. The development of this doctrine is described by F. L. Battles, "God Was Accomodating Himself to Human Capacity," *Interpretation* 31 (1977), pp. 19-38.
10. E.g., *b. Yebamot* 71a and often in the Talmud.

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The Voyage of Noah's Ark—An Epilogue

Elmendorf Responds to Moore

Unaccustomed as I am to defending the Bible (it's much more fun to attack evolution), I will only offer a few specific comments about one particular aspect of Robert A. Moore's lower-criticism article on Noah's Ark, having to do with the design and construction of the vessel.

Before I do that, however, I want to commend you on the special single-article issue of the C/E Journal. For its purpose, the article seems to be very well written, even though the cargo of words is heavily overloaded with straw men. I am sure that the evolutionary faithful out there will be praising Darwin for such an "effective" attack on the Bible.

It is obvious, however, that Moore's own between-the-lines speculation about what actually happened has no more substance or validity than the between-the-lines speculation of the creationist interpreters which he criticizes. With a hundred and some years of history packed into only about sixty verses, it seems to me that the account of the flood is made up mostly of "gaps," with only a few tantalizing bits of data in between, leaving an awful lot of room for arbitrary personal opinion.

Now back to the old arkeological drawing board. My specific comments have to do with the sections on design and construction of the Ark pages 1-5, and are as follows:

(1) I don't think the author gives Noah or his civilization nearly enough credit. Noah himself was eleven times older than I am and much closer to the original source of human intelligence—no doubt enormously smarter and more experienced. Biblical chronology would indicate roughly 1500 years from creation to the flood, which provides plenty of time for the accumulation of a vast amount of human technological knowledge, if in fact such was needed.

The idea that these were primitive nomads in long robes trying to construct an impossible structure in the middle of nowhere with a couple of axes is strictly from Sunday school—one of Moore's straw men. For all we know, Noah may have had both sophisticated know-how and extensive facilities available to him for the project. Who's to prove otherwise?

While I marvel at the accomplishment of such a large construction

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project, I do not by any means view it, like Mr. Moore, as an "impossible" job, even as an individual much younger-and-dumber than Noah.

(2) I challenge Mr. Moore's assertion that "a shipyard in nineteenth-century Maine would have been overwhelmed by the size and complexity of this job." I happen to own and operate a small fabricating shop, and am somewhat familiar with other such shops in this area. I daresay Mr. Moore would be surprised at the "size and complexity" of the projects which are undertaken in such modest facilities. I see building the ark as a tremendous engineering and construction challenge, not an impossible dream, and I would actually love to have been involved in such a project. Since I'm a little late on the scene for that, I'll have to settle for speculating on how it might be done today if someone ordered a wooden barge 45 x 75 x 450 ft., for "delivery" in the year 2103.

(3) Metal working was apparently a known craft at the time the ark was built (Genesis 4/22), so the vessel need not to have been constructed of gopher wood *only*. My *Timber Construction Manual* outlines modern design practice for large structures using various metal fasteners, supports and accessories in addition to the timbers themselves. I see no reason why the ark might not have been constructed the same way.

(4) Mr. Moore's notions about the ark being slammed about and reduced to toothpicks simply do not seem valid for a vessel of that size and tonnage. It is the smaller ships that get knocked around like corks in a rough sea, not the big ones. I can visualize the ark plunging *through* sharp waves, but I cannot visualize it bobbing rapidly like the miniature model which was tank-tested for that film he refers to.

For that matter, nothing is given in the biblical account about the sea conditions which actually occurred during the flood, so we don't even know how rough the surface of the flood was, in order to determine the "design conditions" for roll, pitch, slamming, hogging and sagging.

In any case, the ark could have been designed as an internally-braced box (a very strong shape) for its intended purpose as a floating barge. There would be no need to get into the problems of propulsion and steering associated with sailing ships. Barges of about the size of the ark are made today right here in Pittsburgh.

(5) I visualize a design with the 45 x 75 foot cross section being divided up into perhaps 15 ft. x 15 ft. x 15 ft. crate-like sub-sections, individually constructed in jigs in repetitive fashion, or stick-built in place, to form a continuous lattice as shown in the attached illustration [see p. 41, top].

Appropriate X-bracing would be necessary of course, but need not be continuous once the box-shape is established as a reference foundation, any more than the bracing in a modern rectangular steel-framed building or a wood-frame house is continuous. Some of the X-ing could also come from the

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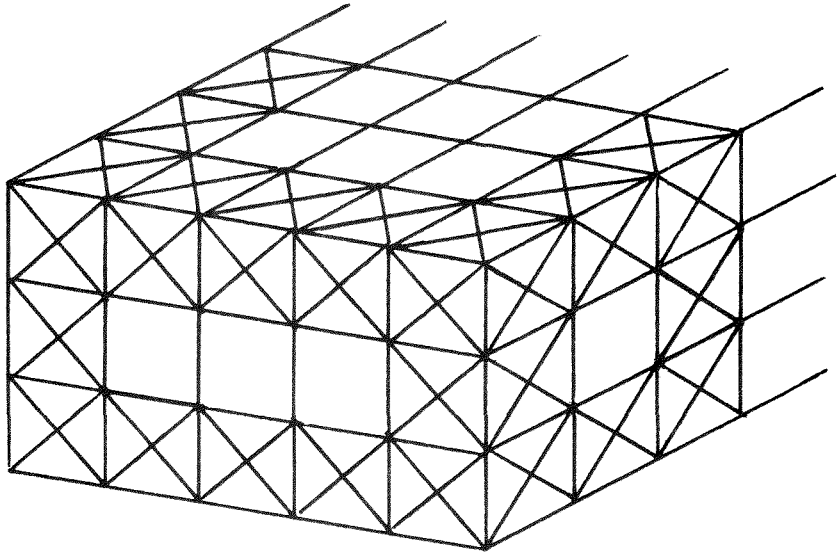

partitions closing off the naturally-formed "rooms" in the lattice structure, combining the functions of a structural membrane and a partition.

This design pattern, establishing structural integrity and strength in each sub-structure, could be enlarged much as a crystal structure grows to practically any size, and for practically any service conditions, at least theoretically.

(6) Room-by-room, and section-by-section, the large, very strong framework of the ark would be constructed, needing only a skin of straight planks (no bending necessary!) and a coat of pitch from the La Brea Tar Pit Co. to complete the job. Whether the ark leaked like a sieve or not would depend on the specific fit and sealing of the individual planks in the skin. Assuming that the work was carefully done and the planks bolted or spiked in place, with provision for caulking if necessary in the joints, I would see no problem in achieving a relatively watertight hull. I have no idea what "gopher wood" was, but assume that it swelled when wet to further seal the skin.

(7) Construction could proceed with a small crew, using modular techniques as described. The "delivery time" was certainly long enough, so careful planning would be justified. I see no need for 100,000 slaves and NASA's nationwide facilities. The thing wasn't "delivered" anywhere, or even "launched." It was *floated* into service. That certainly would have been the "moment of truth" for the builders in more ways than one.

(8) Now what's the matter with that, you anti-biblical skeptics? If you

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want to put my scheme to the test, send me a purchase order, and *I'll build the whole thing on my own property with four men*!

Most of this is just my own brand of between-the-lines speculation, of course, and I do not represent myself as any kind of an "expert" on either shipbuilding or the Bible. It certainly makes intelligent sense, however, at least from an engineering and fabricating viewpoint, to consider the ark as a feasible, if ambitious, construction project. It doesn't require a "thoroughly senseless level of supernaturalism" at all, though I'm not discounting the necessity of that. It seems clear enough, at least with respect to this section of the article, that Mr. Moore's views are largely the result of a will-to-disbelieve rather than an intellectually honest concern with the scientific problems of the Genesis flood.

R. G. Elmendorf

Moore Replies to Elmendorf

The "straw men" which allegedly populate my article are not of my construction but are the work of the creationists themselves. I agree that the story in Genesis has many gaps, but they have been so thoroughly filled in by the fundamentalists that I have no need to set up any models of my own to demolish. And modern creationism is the target of my criticisms, not ancient Semitic myths.

Elmendorf would like to have an advanced pre-diluvian civilization easily capable of constructing the ark. But as I asked in the article, if such a world existed, where is the archaeological evidence for it? If the deluge occurred today, future researchers would find billions of artifacts permitting a thorough reconstruction of 20th century life, yet we are offered only the Paluxy River prints as evidence for any human existence at all! I also noted that Noah and his sons survived the flood by several centuries, but his "enormously" greater intelligence and experience contributed nothing to redeveloping civilization. It is easy to invent lost "Golden Ages"—Atlantis, Cibola, Pre-Diluvia—but without even *one* artifact I cannot accept such stories.

One of the most important "eyewitnesses" who has seen the ark on Mt. Ararat has stated that it was made entirely of wood, including even the nails. But even if metal was used, it would still not be strong enough; diagonal iron strapping was used on the six-masted schooners, which still leaked and were at the limit for sound wood construction. The highly skilled Maine shipyards built these largest of wooden boats, and still they leaked and were unsafe on the open seas. Noah needed a vessel much larger and stronger and completely secure. If the 19th century shipyards didn't come close to achieving this, why should we believe Noah did?

Elmendorf ignored my objections to Noah obtaining pitch. He also missed

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my references to very large ships sinking in storms at sea. And he is simply wrong when he says that we don't have any idea how rough the sea was: the Bible has a forty-day storm burying the entire earth with water, even the mountain tops, and the "fountains of the great deep" opening up, resulting in the annihilation of all life outside the ark. We don't even need the addition of "flood geology" with its mountain-building, volcanism, and continent-splitting to have a cataclysm no ship could survive, but when we study the creationist model, it is clear that neither Noah, any shipyard anywhere, nor Elmendorf could construct a vessel that could make it.

Robert A. Moore

Farquhar Responds to Moore

Congratulations on Volume XI (Volume 4, No. 1)! I was delighted by Robert A. Moore's fascinating treatment of Noah's epic adventures. As a biological oceanographer who has studied deep scattering layers for many years, I often wondered how Noah accommodated mesopelagic fishes and crustaceans which make daily vertical excursions of some hundreds of meters as part of their normal behavior. Of course, in the creationists' antediluvian shallow seas, these animals had not yet evolved. Certainly the creationists would agree, though, that that vital element in the marine food chain—the phytoplankton—was there. One wonders how the myriad species of diatoms, nannoplankton, and other photosynthetic forms were able to get along in the dark confines of the Ark.

A few months ago, I began assembling notes and data for a book on the legend of Noah. Robert Moore's work will be extremely valuable to me.

While reading Mr. Moore's description of Noah's problems in feeding the animals, I thought about those 800 species of bats, at least half of which must be insectivorous. I had a mental picture of a stalwart crew member opening a large box full of moths every evening so that 800 whirling bats could properly eat. But then I remembered—bats hibernate.

G. Brooke Farquhar

Jukes Responds to Moore

That was a great issue by Robert Moore. If he had added some calculation on the water in the flood, it would have made the creationist case even worse. In my item "Two By Two" in Vol. 285 of *Nature* (May 15, 1980) on page 130 I wrote the following:

> If rain fell to a depth of 10,000 ft. (a conservative estimate, insufficient to cover the mountains; actually "all the high hills that were under the whole heaven were covered" and Mt. Ararat is 17,000 feet high), the vol-

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ume of precipitation would have been 393,000,000 cubic miles, which is 1.4 times that of all the water presently on the earth. This rainfall occurred in 960 hours, at a daily rate of 104 ft. Its "drying up" took 167 days. Where did the water go? If it had rapidly entered the interior of the Earth, one would have expected numerous Krakatoa-like explosions. If it had escaped into outer space, why was not all the hydrosphere simultaneously dissipated?

Thomas H. Jukes

Edwords Replies to Jukes

I'm glad you liked Moore's article, but I think your arguments on the flood waters miss the mark. Let me explain.

Creationists hold that the current waters in the oceans are the flood waters. Before the flood, there were only streams and a few springs. All the water was either in the vapor canopy above the earth (which kept out the ultraviolet light and thus allowed there to be "giants in the earth in those days," and people living to those great biblical ages) or below the earth's crust. Most of the water was below so that when the "fountains of the great deep" opened up, all this water came on to the earth.

Now creationists are clear that Ararat was not as tall prior to the flood as it became during the flood. Everest didn't exist. There were only rolling hills in pre-diluvian times. So the present oceans, and the melting of the ice caps, could have covered everything. (Just imagine dumping the continents into the oceans and creating a level earth. Then put the present level of water over everything. That is roughly the creationist scenario for the first weeks of the flood.)

However, during the flood, but after the waters covered the highest mountains, mountain and continent formation began. Ararat rose, Everest formed, and so forth. So the flood was a messy affair, but there is no problem with where the water came from or went to. Creationists solve one problem by creating ten others!

Frederick Edwords

Jukes Replies Back to Edwords

I provided for an increased elevation of Mt. Ararat (17,000 feet) during the flood when I allowed only 10,000 feet of water depth. And remember, Genesis 7:20 states that the mountains were covered—*not* the "rolling hills." I had to postulate that the mountains were 10,000 feet high because many species are found only at high altitudes, and they can't have evolved since the flood. Therefore they were taken on the ark.

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One correspondent actually took me to task for not submerging Mt. Everest!

Thomas H. Jukes

Chambers Responds to Moore

In his last paragraph on page 10, concluding atop page 11, Moore writes, "Obviously, nearly any concessions, any margins of error, can be granted to the creationists within their geological framework *and the flood water would remain a churning, boiling inferno*, easily accomplishing God's intention of destroying the world." (Emphasis mine.)

I believe the statement I have emphasized is scientifically incorrect. Water (H_2O) boils at merely 212° *Fahrenheit*. Moore has noted his calculations giving 2,700° *Centigrade*, based on creationist claims.

The two Soviet Venera spacecraft which perished on the surface of Venus were able to transmit the information that the surface temperature at their landing sites was between 485°C and 465°C, respectively. As you know, the surface of Venus contains *no water*, certainly no oceans.

Venutian surface pressure is 90 times that of earth. Its clouds contain sulphuric acid droplets, which may combine with flourine to make Venutian "rain" the most acid in the solar system. Carl Sagan has hypothesized that by "terra-forming" Venus, we could make it earth-like through the simple introduction of bacteria which produce oxygen, which could live in its *upper* cloud layer which is more like earth's tropics temperature-wise. This would not only change the chemical composition of Venutian clouds, it would change the ratio of chemicals, reducing the surface temperatures and allowing water to precipitate.

The main point in this letter, however, is much more simple. It is that there *would be no oceans* on earth at even 450°C. 212°F is enough, at sea level. Even less heat is needed on the Fahrenheit scale to make the oceans boil at the height of Mt. Ararat, 16,945 ft. As any mountain climber knows, water boils at lower temperatures the higher you climb.

Simple boiling of water is enough to vaporize all the oceans of the earth into steam. And only through cooling do the molecules reform into water droplets.

The best Noah could have hoped for, with all that vulcanism, was a boat with *wheels* until the earth cooled sufficiently to allow the oceans to re-precipitate.

The Bible speaks of the flood waters receding, but nowhere does it claim Noah and his captive zoo spent any time on dry land, until settling on Ararat.

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No matter how foolish creationist claims may be, there would simply be no oceans, no "churning, boiling inferno" as Moore has allowed them.

Earth would be far more like Venus, with a staggering increase in atmospheric pressure to ninety times that of earth, at even 450°C. At 2,700°C, I would speculate that *everything* would be red hot lava, but I am uncertain on that point.

Otherwise, I feel Moore has done splendidly. I would like to have seen something done on the increase in the sheer weight of the planet with an added mantle of at least 16,000 vertical feet of water. What would this do to the earth's rotational speed? Slow it down, or stop it altogether, I'd speculate. Or, possibly it might speed it up. I don't know. But in any case, this is crucial, thanks to the laws of angular momentum (which, I suppose, God would merely "amend" for a time). Dennis Rawlins and I worked this out once, with the conclusion that it would slow or stop the earth, but not the Moon's rotation, causing interesting problems with gravity, possibly the loss into the outer stratosphere of everything not tied down, oceans and all, along with Mr. and Mrs. Noah and their bestiary. (Yes, we allowed for the melting first of the north and south polar ice-caps, but we used the height of Mt. Everest, almost twice that of Ararat, on the assumption that God, perhaps not Noah, knew Everest existed.)

Like David Milne always says, "creationism is more fun than science"!

Bette Chambers

Osmon Replies to Chambers

Did Bette Chambers really catch one? Did the oceans turn to steam? Did Moore give the creationists oceans when they didn't deserve them? Well, it depends on how much heat is available. It takes only a little heat to warm water (only one calorie per gram of water to raise its temperature 1°C). But it takes a lot of heat to convert hot water to steam. (It takes 540 calories to vaporize one gram of water at boiling point.)

So the question is: was there enough heat available to turn the water present to steam? To make her case, Ms. Chambers must show that the creationist descriptions of this catastrophe provide enough energy. Moore gives some clues for calculating this energy. For example, Whitcomb and Morris talk about a gigantic catastrophe exceeding the energy of hundreds of hydrogen bombs. Whitcomb speaks of hundreds of active volcanoes in a later work. So perhaps there is enough energy. But can you hold the creationists to this? Remember how they used to talk about half of the flood water coming from the "vapor canopy"? In their current flood scenario the greater portion of the water came from reservoirs in the earth (and poured out through miraculous

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means). So if Ms. Chambers succeeds, she will force creationists to make further amendments. The whole exercise is valuable in exposing the artifice of the creation model as a ploy for evangelizing in public schools.

Philip Osmon

Chambers Replies Back to Osmon

I'm truly sorry I cannot satisfy Mr. Osmon's quite proper question, namely experimental proof that my surmise is correct (i.e. demonstrable) that Moore gave the creationists too much.

I simply have no laboratory or other facilities for such a demonstration. Yet, something tells me that Moore's own calculations, that the vulcanism and heat created by the grinding of the earth's crust (plate tectonics taking place in so short a time) would produce 2,700°C.

Moore cites his sources for that estimation. And 2,700°C is damned hot. It is exactly six times as hot as the landscape of Venus (450°C).

There are more questions involved than how fast one could heat however many billion kilotons of water. First, obviously, one must calculate how much water there would be on the planet to achieve the scenario in the ark story. However, if theories about Venus are correct, other elements and molecules undergo change as well. Some hold Venus once had water vapor, at the very least. However, none presently exists, or, so little as to be negligible. Instead, flourosulphuric acid vapor forms the "rain" occurring on Venus. The notion of Carl Sagan that Venus can be "terraformed" by the introduction of oxygen-producing bacteria suggests that all sorts of different things happen to molecular combinations at high temperatures, even 450°C, and that the release of atmospheric oxygen would itself *lower* the Veneran temperatures to a more earth-like level.

I "suspect" that given the year or so Noah had to be puttering around with his bestiary, it would have become so hot at 2,700°C that the earth's oceans would have boiled away.

But Mr. Osmon's point is terribly important. This needs demonstration, not speculation. And, I can't demonstrate it. Can Moore?

Bette Chambers

Moore Replies to Chambers and Osmon

On the question of the ocean's temperature, I would strongly suspect that 2,700°C would be sufficient to overcome any vapor pressure or other obstacles and turn the oceans into steam. The thought certainly occurred to me at the time I researched it. However, I didn't pursue it primarily because my article focused on the ark and its problems rather than on the flood per

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se, which deserves a story in its own right. For my purposes it seemed adequate to show that the oceans would've been unsurvivably hot and tumultuous; exactly *how* hot seemed less important. It would be interesting to explore the various meteorological and geophysical difficulties involved with the deluge. How could a severe storm last continuously over the entire globe for forty days and nights? What unusual currents and waves would form in a single worldwide ocean ravaged by hurricane winds, earthquakes, etc.? What effect would all this chaos have on the earth's rotation—or even the moon's? Could one even breathe if the air had a three billion years' supply of volcanic dust in it? Would the oceans boil away? Such questions were beyond the scope of my article, but I think the point I sought is established past any doubt: no life could have survived the flood, either aboard ship or off—and no ark, however well built, could've survived either.

Robert A. Moore

Letters to the Editor

Your comments are welcomed in this column, whether your thoughts relate to articles published in Creation/Evolution, *the creation-evolution controversy as a whole, or letters published here.*

I enjoyed Stephen G. Brush's article "Kelvin Was Not a Creationist" in the Spring 1982 *Creation/Evolution.* Having demolished Morris's claim (made in his January 1972 *Impact* article "Bible-Believing Scientists of the Past" and his subsequent book *Men of Science, Men of God*) that Kelvin was a creationist, Brush suggests that Morris's "entire list (with one exception [Agassiz]) be treated with some skepticism." He also raises questions about Morris's sources. I'll comment on these points, after discussing another.

Morris claimed (incorrectly) that all those listed in his *Impact* article were "strict creationists" and (incorrectly) that "none were theistic evolutionists." Indeed, Morris has often expressed his feelings about theistic evolutionists, as in this selection from an *Acts & Facts* "Director's Column" reprinted in *Up with Creation!*:

> But can't we be *Christian* evolutionists, they say? Yes, no doubt it is pos-

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> sible to be a Christian evolutionist. Likewise, one can be a Christian thief, or a Christian adulterer, or a Christian liar! Christians can be inconsistent and illogical about many things, but that doesn't make them right.

Despite these and other insults he has heaped on theistic evolutionists, Morris included a few theistic evolutionists in *Men of Science, Men of God*!

Kelvin is not the only scientist whose views Morris misrepresented. Consider his treatment of geologist William Buckland. Morris insists that Buckland "did accept the geologic significance of the world-wide Flood." In fact, Buckland was once a leading "diluvialist," claiming that certain superficial geologic features were due to a recent world-wide flood. In the mid-1830s, however, Buckland abandoned diluvialism for the "tranquil flood theory," which asserts that the Noachian Deluge was geologically insignificant.

Finally, there are indications that Morris's research was not necessarily in primary sources. The first half of his entry for Charles Babbage reads as follows:

> Charles Babbage (1792-1871) was a fascinating scientist, in many respects far ahead of his time. Primarily, he worked on what we now would denote "operations research." He developed the first actuarial tables, invented the first speedometer, and the first skeleton keys, as well as the first ophthalmoscope and the locomotive "cowcatcher."

In the revised edition of *Asimov's Biographical Encyclopedia of Science & Technology*, we find the following:

> Babbage worked on what would now be called "operations research" . . . Babbage worked out the first reliable actuarial tables (the sort of thing which is now the insurance company's bread and butter), worked out the first speedometer, and invented skeleton keys and the locomotive "cowcatcher."
>
> Babbage invented an ophthalmoscope in 1847, by means of which the retina of the eye could be examined. . . .

The only part of Morris's biography of Babbage which couldn't derive from Asimov is one sentence about Babbage's Bridgewater Treatise (a numerical analysis of Biblical miracles).

Robert J. Schadewald

It may interest you to know that when I was in Australia this summer, I purchased a paperback: The Crumbling Theory of Evolution by J. W. C. Johnson, published by the Creation Science Foundation, P.O. Box 302, Sunnybank, Queensland, 4109. Sunnybank is a suburb of Brisbane, and although I was in Brisbane there was no time to visit the Australian creationists. The book costs $2.75 Australian. It relies very heavily on American creationist literature, almost a rewrite of the American books and papers. The most interesting thing about it is that the book carries a Nihil Obstat, and Imprimatur by

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the Archbishop of Brisbane! I can't recall any other instance of a creationist publication carrying an official endorsement by the Catholic Church.

Emmanuel I. Sillman

Proponents of evolution commonly do their cause a disservice by confusing the terms "scientific principle" and "theory." Your own periodical is a case in point—it commonly refers to "the theory of evolution."

The basic concept of "organic evolution" ("evolution," for short) is simple: During the time there has been life on Earth, that life has undergone change.

The way to test the idea of evolution is to examine the evidence we have about life in the Earth's past. And just what evidence do we have? Fossils, of course.

In the last two centuries, literally thousands of people have studied the rocks of our planet and the fossils these rocks contain. These studies have confirmed time and again that the fossils in the oldest fossil-bearing rocks are different from those in rocks somewhat younger, and those, in turn, are different from the remains in rocks even younger, and so on to the present.

That fossil assemblages succeed one another in the same order has been observed time after time, all around our globe. This "biotal succession" or "faunal succession" of fossils is an observable fact. Every time it's been tested, the results have been the same!

Because fossils are the remains and traces of past life, the conclusion is inescapable: In the time that life has existed on planet Earth, that life has changed. Thus evolution is a scientific principle—a fact-disciplined general truth—not just a theory.

R. A. Davis
Paleontologist and
Curator of Collections
Cincinnati Museum of
Natural History

Regrettably, two recent contributors to your publication have adopted a tactic previously exercised with substantial skill only by certain creationist authors in the creation-evolution controversy. Both J. B. Gough and Robert Schadewald (Issue XII, Spring 1983) have chosen to redefine, and therefore obscure, words in no need of redefinition and certainly in no need of obscuring. The abused words are, respectively, "scientist" and "catastrophist."

Gough (p. 31) claims that "to say a person is a scientist encompasses the fact that he or she is an evolutionist." Now, any of a number of acceptable definitions of "scientist" are in common use. One such is: an individual extensively trained in a scientific discipline whose work follows accepted stan-

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dards of design, conduct, and peer review. The definition of a scientist need not be belabored, nor this particular one insisted upon; the point is that *any* reasonable definition cannot be made to include only evolutionists except by arbitrarily appending "and believes in evolution" to the definition. This is precisely what Gough has done, and having redefined "scientist" to mean "scientist who believes in evolution," he can conclude that all scientists are evolutionists. The conclusion and the premise being identical, the former follows logically, though not helpfully, from the latter. No logical objections arise to the possibility that all scientists could, even should, be evolutionists, but the reality is that not all are. Philip Kitcher (*Abusing Science*, 1982, p. 179) lists several who are not, and even a superficial acquaintance with creationist authors will indicate that whatever else we may say about them, we must acknowledge that some creationists are, by any objective, reasonable definition of the word, scientists.

Schadwald's abuse of the language is similar. His point is that diluvialists are not catastrophists because "true catastrophists" reject diluvialism (p. 22). And around and around we go. The term "catastrophism," as pointed out by Derek Ager (*The Nature of the Stratigraphical Record*, 1981, p. 44) is used in contrast with the idea of substantive uniformitarianism to denote the concept that violent geological processes (i.e., catastrophes) operating at rates exceeding those now being observed, are responsible for having produced portions, even most, of the geological record. "Catastrophist," then, has a clear and useful meaning, and Schadewald is not free to decide arbitrarily that it is limited to one particular school of catastrophists. Certainly, creationists' "catastrophist" (flood) geology is very different from Cuvier's catastrophist geology, but then so is Ager's, and no one wishes to deny him his right to call himself a catastrophist. Indeed, we must insist on it, for that is precisely what he is. The term is not sufficiently narrow to exclude flood geology, irrespective of our own opinions of the scientific merit of that particular school of catastrophism.

Creation/Evolution's objective of discussing creationist views on their merits is commendable. Insofar as Schadewald and Gough have contributed to this discussion, and, indeed, both have, their articles are also commendable. Their attacks on the plain meaning of two very useful words, however, are not. Please, spare the language.

Jonathan Young

I think *Creation/Evolution* is an excellent journal in its scientific refutation of creationism. However, as a libertarian, I must disagree with

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your position on public (state) schools.

Libertarians believe that individuals have the right to live in any way they please, as long as they do not interfere with the right of others to live in any way they please. This principle has many implications, one of which is that it is a denial of rights to force any person to support anything against his or her will. The state schools necessarily violate everybody's rights as all are forced to support them.

The only solution to this massive violation of the rights of every American is to get the government out of education so that a free market in education can develop. Evolutionists and creationists can each support and attend their own schools. Separation of education and state is no less a necessary component of freedom than is separation of church and state.

Creationism is wrong. But creationists violate no one's rights merely by believing in a falsehood. State schools, no matter who controls them (and someone must), are coercive institutions which violate everyone's rights.

Howard L. Glick

Advice from Luther Sunderland to his Fellow Creationists

Luther Sunderland, New York's leading creationist, wants his colleagues to be careful when discussing the subject of origins in educational and scientific circles. Among his warnings is this most interesting item—"Do not talk about a flood because there is no way a single world flood can be derived from scientific evidence alone. Talk about global catastrophes."

(P. 185, *Scopes II: the Great Debate*
by Louisiana State Senator Bill Keith)

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